VOL. 5 NO. 17
September 15, 1980

Energy Research Abstracts

ABSTRACTS 26762-28261

Technical Information Center
UNITED STATES DEPARTMENT OF ENERGY

CURRENT AWARENESS PUBLICATIONS ON ENERGY

To provide complete coverage of literature related to major Department programs, announcement publications are regularly issued which are comprehensive in their coverage of certain energy fields. All information in these publications, plus additional backup information, is included in the energy data base of the Technical Information Center; all references are also available for machine searching via the on-line retrieval system, DOE/RECON. Descriptions of these current awareness publications, which are supported either directly or indirectly by the DOE, appear below.

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Fusion Energy Update

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Coal Abstracts (Published in cooperation with the Technical Information Center by the International Energy Agency, IEA Coal Research, London, England)

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ENERGY RESEARCH ABSTRACTS

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The Technical Information Center, as the national information center for the Department of Energy, manages, publishes, and disseminates scientific, technical, and practical energy information acquired from worldwide sources. It builds and maintains energy information data bases used to prepare this and other abstracting journals and bibliographies. The data bases are also searchable via the Department's on-line retrieval system, DOE/RECON. This information is provided to DOE program offices, contractors, scientists, engineers; educational, commercial, and industrial communities; and the general public. The Technical Information Center conducts an active announcement and marketing program. It establishes policy and administers control of a DOE-publications inventory and registry. TIC also develops and evaluates new and effective information systems and services as required by scientific and technical management within the Department of Energy.

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Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U. S. Department of Energy, its laboratories, energy centers, and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. The user should remain aware that *ERA* coverage of non-report literature is limited to that generated by Department of Energy activity.

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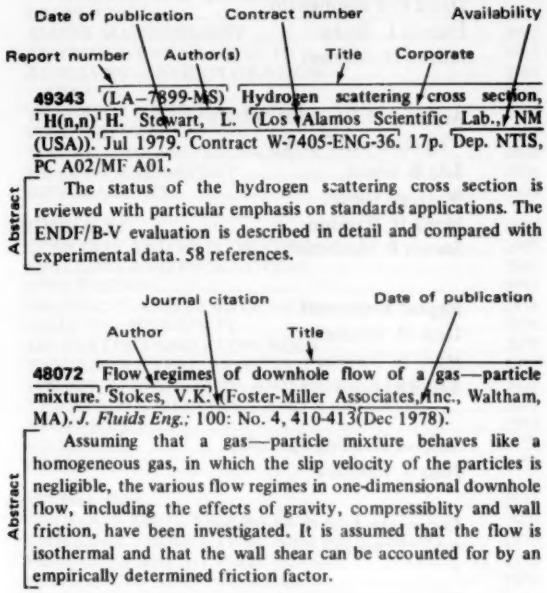
Date of publication
Contract number
Availability
Report number
Author(s)
Title
Corporate
49343 (LA–7899-MS) Hydrogen scattering cross section, ¹H(n,n)¹H. Stewart, L. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.
Abstract
The status of the hydrogen scattering cross section is reviewed with particular emphasis on standards applications. The ENDF/B-V evaluation is described in detail and compared with experimental data. 58 references.
Journal citation
Date of publication
Author
Title
48072 Flow regimes of downhole flow of a gas—particle mixture. Stokes, V.K. (Foster-Miller Associates, Inc., Waltham, MA). J. Fluids Eng.; 100: No. 4, 410-413 (Dec 1978).
Abstract
Assuming that a gas—particle mixture behaves like a homogeneous gas, in which the slip velocity of the particles is negligible, the various flow regimes in one-dimensional downhole flow, including the effects of gravity, compressiblity and wall friction, have been investigated. It is assumed that the flow is isothermal and that the wall shear can be accounted for by an empirically determined friction factor.

•INDEXES TO *ENERGY RESEARCH ABSTRACTS*

Five indexes are provided for approaching the contents of each issue of *Energy Research Abstracts (ERA)*. These indexes are cumulated semiannually and annually. Each index is preceded by an introduction that details the organization of the index and the principles by which it was compiled. The reader is referred to these introductions for information not found in the index examples that follow.

•Corporate Index

Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

49343 (LA–7899-MS) Hydrogen scattering cross section, ¹H(n,n)¹H. Stewart, L. **(Los Alamos Scientific Lab., NM (USA)).** Jul 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.

is indexed as:

Los Alamos Scientific Lab., NM (USA)
Advanced laser fusion target fabrication research and development proposal, 4:48249 (LA–7619-P)
Hydrogen scattering cross section, ¹H(n,n)¹H, 4:49343 (LA–7899-MS)

•Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

Stewart, L., Hydrogen scattering cross section, ¹H(n,n)¹H, 4:49343 (LA–7899-MS)
Stewart, M.D., *See* McInroy, J.F., 4:49280
Stewart, W., *See* Dean, J.W., 4:48543
Stimson, J., Reproduction, growth, and survival of Enewetak corals, 4:49200 (NVO–0703-1, pp 56-59)

•Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

HYDROGEN 1 TARGET/NEUTRON REACTIONS
Hydrogen scattering cross section, ¹H(n,n)¹H (Above 100 keV, review), 4:49343 (LA–7899-MS)
HYDROGEN NITRATES
See NITRIC ACID
HYDROLOGY/RESEARCH PROGRAMS
Inventory of advanced energy technologies and energy conservation research and development: 1976-1978. Volume II. Prepared for the Committee on Science and Technology, U.S. House of Representatives, Ninety-Sixth Congress, 4:48749

•Contract Number Index

DOE technical report literature is indexed using contract numbers. This index contains the contract number with corresponding abstract and report numbers.

W-7405-ENG-36	**Los Alamos Scientific Lab., NM (USA)**	
	3:49698	LA-tr–78-45
	3:49857	LA–7224T
	3:49863	LA–7235-MS
W-7405-ENG-48	**California Univ., Livermore (USA). Lawrence Livermore Lab.**	
	3:49386	UCRL–52456
	3:49431	UCRL–52405

•Report Number Index

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

LA-		
7899-MS	4:49343	Dep. NTIS, PC A02/MF A01
LA-tr-		
78-69	4:48158	Dep. NTIS, PC A03/MF A01

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ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

26762 (NP—24429) **IEA Coal Research annual report, 1979.** (NCB (IEA Services) Ltd., London (England)). 1979. 24p. NTIS (US Sales Only), PC A02/MF A01.

This report describes the work of the four Coal Technology Projects managed by NCB (IEA Services) Ltd., namely the Technical Information Service, the Economic Assessment Service, the World Coal Resources and Reserves Service, and the Mining Technology Clearing House Service. The collection and dissemination of information on coal technology has been continued. Coal Abstracts contains an average of some 500 abstracts per month from journal articles, reports, conference papers, and monographs from 30 countries; 733 copies of Coal Abstracts are distributed in member countries and there are 19 subscribers in 18 countries, including China and the USSR. The scope of the work of the Economic Assessment Service has been extended into technical fields with increasing relevance to topical issues such as the economics of coal based electricity generation and the cost of liquid fuels from coal. The work being undertaken on these topics is described. The Resources and Reserves Service has now decided and agreed upon a definitive and logical basis for the assessment of reserves, and the procedure for obtaining data and extracting results is now in full operation. The Clearing House has published a full set of Project Registers detailing mining Research and Development work, and initiated a multilateral cooperative program in Hydrotransport. During 1980 further subjects for collaboration will be defined.

26763 (ORNL/TM—7322) **Fossil energy program. Progress report for March 1980.** (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 116p. NTIS, PC A06/MF A01.

This report - the sixty-eighth of a series - is a compendium of monthly progress reports for the ORNL research and development programs that are in support of the increased utilization of coal and other fossil fuel alternatives to oil and gas as sources of clean energy. The projects reported this month include those for coal conversion development, chemical research and development, materials technology, component and process evaluation studies, technical support to major liquefaction projects, process analysis and engineering evaluations, fossil energy environmental analysis, coal preparation and waste utilization, coal preparation plant automation, atmospheric fluidized bed coal combustor for cogeneration, technical support to the TVA fluidized bed combustion demonstration plant program, coal cogeneration/district heating plant assessment, and performance assurance system support.

PROCESSING

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 27565

26764 (FE—2357-54) **PFB coal fired combined cycle development program. Quarterly report, January-March 1979.** (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). 1979. Contract EX-76-C-01-2357. 49p. NTIS, PC A03/MF A01.

The systems engineering scope of work in Task I has been directed towards (a) replacement of the Aerodyne Cyclone and Granular Bed Filter with an electrostatically enhanced cyclone configuration, (b) replacement of the vertical PFB with a horizontal PFB, and (c) revision of the plant layout to reduce the length of both the lined refractory and main steam piping. During this period two gas turbine material burner rig stands were placed in operation, one at 1400F and the second at 1600F, utilizing 1% S in diesel oil containing 79 ppM Na, 112 ppM K, and 16 ppM Mg. All required specimens to be exposed in the NCB/CURL 10 x 100 Hour Test have been received. Overall efficiency, fractional efficiency, and pressure loss measurement for the first stage cyclone to be used in the CURL 10 x 100 Hour Test have been obtained under cold flow, laboratory conditions. Based on these results, performance projections have been made for the actual hot-flow test to be run at CURL. The performance is comparable to that of a well designed, conventional cyclone, but far exceeds that previously measured on the two-stage Aerodyne which it will be replacing in the cleanup train at CURL.

26765 (FE—9060-2) **Coal desulfurization by low temperature chlorinolysis. Phase II. Final report.** Kalvinskas, J.; Grohmann, K.; Rohatgi, N.; Ernest, J.; Feller, D. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Jan 1980. Contract ET-77-1-01-9060. 148p. (JPL-PUB—80-15). NTIS, PC A07/MF A01.

Coal desulfurization by low temperature chlorinolysis was conducted by the Jet Propulsion Laboratory, California Institute of Technology. An engineering scale batch reactor system was constructed and operated for the evaluation of five high sulfur bituminous coals obtained from Kentucky, Ohio and Illinois. Forty-four test runs were conducted under conditions of 100 x 200 mesh coal, solvents - methylchloroform and water, 60 to 130°C, 0 to 60 psig, 45 to 90 minutes and gaseous chlorine flow rate of up to 24 SCFH. Sulfur removals demonstrated for the five coals were: maximum total sulfur removal of 45 to 66%, pyritic sulfur removals of 71 to 95% and organic sulfur removal of 46 to 89% (4 of 5 coals with methylchloroform) and 0 to 24% with water. In addition, an integrated continuous flow mini-pilot plant was designed and constructed for a nominal coal feed rate of 2 kilograms/hour which will be operated as part of the follow-on Phase III program. Equipment flow sheets and design drawings are included for both the batch and continuous flow mini-pilot plants.

26766 **Coal desulfurization by the Gravichem Process.** Meyers, R.J.; Santy, M.J. (TRW, Redondo Beach, Calif). *Pollut. Eng.*; **11**: No. 11, 46-49(Nov 1979).

A revised coal preparation technology that is termed the Gravichem Process is described and a process schematic is shown. Coal is mixed with an acidic solution of ferric sulfate, previously derived from coal, to form a slurry. The slurry is raised in temperature to 100 to 130 C where the ferric sulfate oxidizes the pyritic sulfur to form elemental sulfur and additional iron sulfate. At the same time oxygen or air is introduced to regenerate the reacted ferric sulfate. Iron sulfate dissolves into the leach solution while the elemental sulfur is removed in a second extraction. The coal is dried and solvent-recovered.

26767 (FE—2357-52) **PFB coal fired combined cycle development program. 10 x 100 Hr test plan.** (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). [nd]. Contract EX-76-C-01-2357. 101p. NTIS, PC A06/MF A01.

The United States Department of Energy (DOE) has contracted with the National Coal Board/Coal Utilization Research Laboratory to perform a 10 x 100 hour test program in the (Leatherhead, England) Pressurized Fluidized Bed test facility. A number of organizations and companies are participating in the test program. The main activities and sponsors are listed and an overall schematic of the test facility is shown. In a test leg parallel to the S-L materials test section, but connected in common to the BCL Ltd Combustor, the Energy Systems Programs Department of the General Electric Company, under DOE sponsorship, will test a turbine materials test section and a hot gas cleanup train. The materials test section will contain cooled and uncooled specimens of candidate gas turbine materials. The hot gas cleanup train will consist of a swirl settling chamber to investigate electrostatic effects followed by two 10

cyclones in series incorporating advanced features developed as part of cold flow testing. Additionally, the facility will contain instrumentation to determine the performance and test history of each component as well as experimental laser based equipment designed to make real time measurements of particle size loading and distribution in the hot gas stream. Experimental electrostatic particle detectors will be installed to provide real time measurements of variations in the particulate loading leaving the combustor and at the entry to each turbine test section.

GASIFICATION

REFER ALSO TO CITATION(S) 26803, 26809, 26810, 26811

26768 (ANL-FE—49628) **Overview of coal conversion process instrumentation.** Liptak, B.G.; Leiter, C.P. (Argonne National Lab., IL (USA)). May 1980. Contract W-31-109-ENG-38. 197p. NTIS, PC A09/MF A01.

A review of standard instrumentation used in the processing industries is given, and the applicability of this instrumentation to measurements in mixed phase media and hostile environments such as those encountered in coal conversion processes is considered. The major projects in coal conversion sponsored by the US Department of Energy are briefly reviewed with schematics to pinpoint areas where the standard instrumentation is inadequate or altogether lacking. The next report in this series will provide detailed requirements on the instruments needed for these processes, will review new instruments which have recently become commercially available but are not yet considered standard instrumentation, and report on the status of new instruments which are being developed and, in some cases, undergoing tests in coal conversion plants.

26769 (DOE/ET/13060—25(Vol.5)) **Environmental report. Phase I: the Pipeline Demonstration Plant. Volume 5. Environmental data Appendices B-E.** (Conoco, Inc., Stamford, CT (USA)). 1980. Contract AC01-77ET13060. 275p. NTIS, PC A12/MF A01.

Contract No. EF-77-C-01-2542 between Conoco Inc., and the United States Department of Energy requires Conoco Inc., to design, construct and operate a Demonstration Plant capable of converting eastern US bituminous coals into pipeline quality gas. The main purpose of the project is to demonstrate technology which can produce clean fuels from coal in a safe, reliable, and environmentally acceptable manner. A site consisting of about 1245 acres in Noble County, Ohio, has been tentatively selected for the location of the Demonstration Plant. A comprehensive environmental study and an assessment of the effects of the Demonstration Plant on the Environment have been undertaken and completed by Energy Impact Associates of Pittsburgh, Pennsylvania. A six volume Environmental Report covering the environmental study and assessment has been prepared: Vol. 1, Project Description; Vol. 2, Existing Environment; Vol. 3, Project Impact and Alternatives; and Vols. 4 to 6, Environmental Data. This is Volume 5. It consists of the following four appendices which contain environmental data and information gathered by Energy Impact Associates: B, Seismology; C, Surface Water Hydrology; D, Water Quality; and E, Groundwater Hydrology.

26770 (DOE/ET/13060—25(Vol.6)) **Phase I: the pipeline gas demonstration plant. Volume 6. Environmental data appendices F-H. Environmental report.** (Conoco, Inc., Stamford, CT (USA)). 1979. Contract AC01-77ET13060. 270p. NTIS, PC A12/MF A01.

Contract No. EF-77-C-01-2542 between Conoco Inc. and the United States Department of Energy requires Conoco Inc. to design, construct and operate a Demonstration Plant capable of converting eastern US bituminous coals into pipeline quality gas. The main purpose of the project is to demonstrate technology which can produce clean fuels from coal in a safe, reliable, and environmentally acceptable manner. A site consisting of about 1245 acres in Noble County, Ohio, has been tentively selected for the location of the Demonstration Plant. A comprehensive environmental study and an assessment of the effects of the Demonstration Plant on the environment have been undertaken and completed by Energy Impact Associates of Pittsburgh, Pennsylvania. A six volume Environmental Report covering the environmental study and assessment has been prepared: Volume 1, Project Description; Volume 2, Existing Environment; Volume 3, Project Impact and Alternatives; and Volume 4-6, Environmental Data. This is Volume 6. It consists of the following three appendices which contain environmental data and information gathered by Energy Impact Associates: Appendix F, Air Quality and Meteorology; Appendix G, Terrestrial Ecology; and Appendix H, Aquatic Ecology.

26771 (DOE/ET/14696—T2) **Peat biogasification development program. Quarterly progress report No. 2, January 1-March 31, 1980.** (Dynatech R/D Co., Cambridge, MA (USA)). 1980. Contract AC01-79ET14696. 54p. NTIS, PC A04/MF A01.

Batch experiments have been performed to determine the effects of different alkalis, temperatures, retention times, solids loading, and oxygen partial pressures on the solubility of peat organic material. Oxidation experiments have been performed simultaneously with and separately from solubilization. In both cases kinetic information has been developed based on oxygen consumption. Kinetics based on fermentable product formation are dependent on satisfactory identification methods. Development of analytical procedures for product identification have included: Gel Permeation Chromatography (GPC), solvent extraction, aldehyde precipitation, and Thin Layer Chromatography (TLC). Microorganisms from three inoculation sources are being grown anaerobically using a growth medium containing a standard nutrient and a specific substrate, one of twelve aromatic compounds. The concentration of aromatic compound was increased gradually in order that bacteria acclimate for future use as inocula with pretreated peat liquors. Acids and methane production are being monitored for pretreated peat liquor fermentations using an acclimated microorganism inocula. Apparent viscosity and apparent heat transfer coefficient data are being obtained at three peat slurry solids concentrations (3-5, 10, 15% total solids). A 75% heat recovery would give a positive energy balance around the pretreatment reactor. Development has continued in regards to full scale peat biogasification design (75 x 10^6 SCFD, pipeline quality methane). The information necessary for continuous PDU scale operation is being evaluated in terms of what processing information may be obtained from various scale units, batch and continuous.

26772 (DOE/ET/14705—1) **Bi-gas pilot plant operation. Technical progress report, 1 November-30 November 1979.** (Stearns-Roger Corp., Denver, CO (USA)). 1979. Contract AC01-80ET14705. 91p. NTIS, PC A05/MF A01.

Broadly, current goals are to assess the viability of the process from an operating and cost standpoint, determine possible improvements and obtain design data for a full scale plant. As is typical for developmental projects of this magnitude, a large number of operating difficulties have been experienced and overcome since the first operations in August of 1976. Currently the overcoming of operating difficulties still requires a major effort. However, the plant is becoming increasingly stable and operable and planning is underway to allow future efforts to include process operating characterizations, improvements, and the gathering of design data. This report is mainly a summary report of Test G-9 and G-10.

26773 (DOE/EV/10286—1) **Impact of RCRA on coal gasification wastes.** (Hart (Fred C.) Associates, Inc., New York (USA)). Aug 1979. Contract AC02-79EV10286. 89p. NTIS, PC A05/MF A01.

Coal conversion processes offer the potential for almost every possible mode of environmental contamination. Potential environmental pollution will occur from huge streams of wastewater, scores of gaseous vents and enormous quantities of solid materials. The nature of the waste streams is of particular concern in view of the recently enacted Resource Conservation and Recovery Act (RCRA). The passage and implementation of RCRA poses new levels of control for the traditional solid waste disposal process and establishes a new set of material standards for hazardous wastes in which conforming materials will require even more stringent controls. Key definitions in the Act which may pertain to coal gasification wastes include hazardous waste, sludge and solid waste. It is the goal of this report to collect, analyze, and interpret data and other technical information relevant to solid waste by-product generation, handling, and disposal at existing and future coal conversion plants. The analysis and interpretation of the collected data has been directed towards identifying gaps in the data, potential problem areas in solid waste disposal in view of RCRA, and needed research activities in the area of solid waste disposal.

26774 (DOE/ID/01570—T5) **Materials for coal gasification. Effect of environment on stress rupture.** Horton, R.M. (EG and G Idaho, Inc., Idaho Falls (USA)). 1980. Contract AC07-76ID01570. 8p. NTIS, PC A02/MF A01.

The biaxial stress rupture behavior for two of the alloys, Type 310 stainless steel and Haynes 188, is shown in figures. The other two alloys show similar behavior. The rupture parameter, P, is an empirical quantity which reflects the simultaneous effects of both temperature and duration of applied stress on stress rupture. Based on these results, several trends are apparent: (1) the biaxial stress rupture tests show the same trends and approximately the same stress rupture values as uniaxial data obtained from the literature for each alloy tested; (2) only for the Haynes 188 may the stress rupture strength/life in CGA have been significantly less than in air. But further testing has indicated there is probably no reduction of biaxial stress rupture strength/life in CGA even for this alloy; (3) the biaxial strain at rupture was small, typically only a few percent. It is appropriate to mention that in the uniaxial stress rupture testing at SwRI, exposure to CGA generally resulted in a shorter rupture life than with testing in air. No explanation is yet available for the observed difference in behavior between SwRI and INEL test specimens.

26775 (EGG-RE-M—79-019) **Materials testing at the Hanna IV in situ coal gasification experiment site during FY 1978.** Scoonover, T.M.; Keefer, D.W. (EG and G Idaho, Inc., Idaho Falls (USA)). Dec 1979. Contract AC07-76ID01570. 70p. NTIS, PC A04/MF A01.

Candidate structural alloy specimens were exposed for about 800 hours to the direct product gas stream from the Hanna IV underground coal gasification experiment. When the specimens were removed from the line, they were coated with high-sulfur deposits from the product gas. A chemical analysis and the physical appearance of the coatings suggest that they are mixtures of condensed hydrocarbons, coal char, coal ash, and mineral particles from the overburden. Attack on the specimens was primarily corrosion rather than erosion. Mean penetration rates expressed in millimetres per year (mm/y) and mils per year (mpy) were calculated from weight loss data. Microscopic examination revealed some areas of rather severe local attack on all alloys tested. There was no consistent difference in the amount of material removed from specimens with welds and those without welds. Specimens exposed at 45° to the product gas flow all had surface dents from impacting particles while parallel specimens had none. Energy-dispersive x-ray and Auger electron spectra indicate that the few particles of deposits and/or corrosion products still clinging to the specimen surfaces after cleaning were oxides, rather than sulfides, with significant contents of aluminum and silicon in addition to iron.

26776 (FE—1548-T1) **Experimental and process design study of a high rate entrained coal gasification process. Final report, January 1974-November 1978.** McIntosh, M.J.; Coates, R.L. (Eyring Research Inst., Provo, UT (USA)). 1978. Contract EX-76-C-01-1548. 421p. NTIS, PC A18/MF A01.

The objectives of the project were to: demonstrate stable, reliable, long term, continuous operation of a pressurized, downflow, entrained, laboratory scale coal gasification pilot plant; develop a mathematical model of the gasification reactor which will characterize the gasification properties of the coals and correlate the data; and apply the model to studies of integrated gasification, combined-cycle efficiencies. A total of 296 test runs were made for a total of 800 operating hours. Cold gas efficiencies of 73 percent at specific gasification rates of 115 pounds coal/hour ft^3 atmospheres have been achieved. Extensive equipment modifications have been made to overcome problems with non-uniform coal feeding, feed injector plugging, refractory overheating, heat recovery section plugging and scrubber discharge plugging. An extended series of runs on a range of feed coals and char were conducted. Using the results, a semi-emperical mathematical model was developed. Mathematical models of the entrained gasifier integrated in various ways with a combined cycle system have been developed and used to study the effect of mode of integration, coal type, gasifier heat loss and gasifier steam feed rate on combined cycle performance. As part of the project Ford Bacon and Davis of Utah Inc. (FBDU) performed a detailed cost and engineering analysis of the scaled up high rate entrained gasification process. Their conclusions are favorable based on the simplicity of the process, thermal efficiency and the use of commercially-proven equipment. (LTN)

26777 (FE—1792-58) **Coal feeder development program. Quarterly technical progress report.** (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA (USA)). Jun 1979. Contract EX-76-C-01-1792. 50p. NTIS, PC A03/MF A01.

Tests are reported for the Model 3 rotor operating in the horizontal axis position. These results show no change from the favorable data obtained using a vertical axis. Details for the Model 4 rotor system are given, and laboratory test results reported indicate that the basic feeder is compatible with a wide range of feed stock. Coals with moisture content to about 20% have been tested. A preliminary design for a 20 ton/h feed system is presented.

26778 (FE—1894-57) **Program to discover materials suitable for service under hostile conditions obtaining in equipment for the gasification of coal and other solid fuels. Quarterly progress report, July 1-September 30, 1979.** Humphreys, B.A.; Hill, V.L.; Yurkewycz, R. (Metal Properties Council, Inc., New York (USA)). 28 Jan 1980. Contract EX-76-C-01-1784. 161p. NTIS, PC A08/MF A01.

This report describes the progress on a program under the direction of The Metal Properties Council, Inc., designed to screen materials for use in such plants with respect to the various unique corrosive environments obtaining therein; and, finally, to provide useful corrosion data as well as reliable information on other properties needed for the design, construction and operation of such plants. This program is sponsored by the US Department of Energy and the Gas Research Institute. A summary of achievements in this quarter follows: High-temperature corrosion test runs were continued. Run 54 completed 4000 hr of expousre, and Run 55 completed over 3000 hr of exposure during the period. Metallographic analyses of specimens from Run 55 after 3000 hr exposure were completed. Interpretive analysis of test specimens from the current and earlier 10,000 hr tests was continued. Metals and refractories were exposed in the HYGAS pilot plant. Aqueous corrosion tests 335 and 336 (150 hr) and 1000 hr tests 905, 906, 907, and 908 were completed in the modified HYGAS environment. Tests 910 (1000 hr) and 909 (500 hr) were initiated. Interpretive analysis of coupons was continued. Erosion/corrosion test runs at atmospheric and high pressure were completed. All gravimetric and micrometric data were obtained and metallographic examination was initiated. The testing program at Southwest Research Institute is proceeding on funds supplied by GRI. Some stress rupture test results are reported at this time. (LTN)

26779 (FE—2218-34) **Improvement of the mechanical reliability of monolithic refractory linings for coal gasification process vessels. Third annual progress report, July 1978-June 1979.** Anderson, E.M. (Babcock and Wilcox Co., Lynchburg, VA (USA). Materials and Chemical Technology Lab.). Aug 1979. Contract EX-76-C-01-2218. 78p. NTIS, PC A05/MF A01.

The third annual report briefly describes the overall status of the program at the end of the third year and emphasizes the work and progress during the twelfth quarter. The experimental data collected on Lining No. 7 which is a dual component lining with metal fibers in the dense component are presented and compared to previous lining test results. The findings of a series of small scale special tests which were designed to evaluate materials and possible lining configurations for Linings Nos. 8 and 9 are described. The current status of the acoustic emission monitoring technique for detecting cracking is reviewed.

26780 (FE—2666-F(Vol.1)) **Mixing and gasification of coal in entrained flow systems. Final report, 1 May 1977-31 October 1979.** Smoot, L.D.; Hedman, P.O.; Smith, P.J. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemical Engineering). 31 Jan 1980. Contract EF-77-S-01-2666. 225p. NTIS, PC A10/MF A01.

This document summarizes research accomplishments of a thirty month, second phase study of mixing and kinetic processes in an entrained coal gasifier. Principal objectives were to measure the extent of particle reaction and dispersion, the extent of gas mixing, the local product composition, and the extent of pollutant formation. Additional objectives included the completion of the one-dimensional computerized model for describing entrained coal gasification systems and the use of that model in analyzing the gasification processes, and extension of the coal reaction model to two-dimensional systems. Non-reactive mixing tests were completed to quantify gas and particle mixing rates independent of chemical reaction. Sixty tests were completed in two different sized ducts where the effects of mixing chamber diameter, secondary velocity, particle size, solids-loading and the influence of a primary wire screen were investigated. The final cold flow tests involved a major facility modification to introduce swirl into the secondary stream. A series of preliminary tests to check-out the modified hardware, and a series of 28 experiments to quantify the effects of secondary swirl on gas and particle mixing rates were completed. Gasification tests were performed in a laboratory-scale entrained coal gasifier which was equipped with a set of water-quench sample probes. Gas and particle samples were extracted from the gasifier and analyzed to determine the extent of gas mixing, particle dispersion and reaction, and gaseous reaction products including nitrogen and sulfur pollutants.

26781 (FE—2666-F(Vol.2)) **Mixing and gasification of coal in entrained flow systems. Volume 2. User's manual for a computer program for 1-dimensional coal combustion or gasification (1-DICOG). Final report.** Smoot, L.D.; Smith, P.J. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemical Engineering). 31 Aug 1979. Contract EF-77-S-01-2666. 215p. NTIS, PC A10/MF A01.

A one-dimensional, steady-state model describing pulverized coal combustion and gasification is presented. While emphasis has been placed on the description of the coal reaction processes and gas-particle interactions, one-dimensional fluid mechanics and particle-particle, particle-wall radiation have been included. Moisture vaporization from the coal particles, multi-step coal pyrolysis, and heterogeneous char oxidation by multiple oxidizers are modeled for polydispersed coal particle sizes or types. Although the formulation is one-dimensional, mixing rates of primary and secondary streams and recirculation within the reactor have been accounted for as specified input. The resulting model predicts thermal, chemical and physical histories for both the gaseous and particle phases. Gas-particle interactions account for appropriate diffusion and kinetic rates. Gas phase reactions are assumed to be in local chemical equilibrium. The solution technique uses predictor-corrector methods for integration of the ordinary non-linear differential equations which are coupled with a number of auxiliary algebraic equations. An iterative approach is required for the radiant heat transfer calculations by the zone method. Stiffness in differential energy equations is overcome by a pseudo steady-state method when needed. The generalized nature of the model allows for calculation of both coal combustion and coal gasification characteristics. This code can be obtained at a minimal cost from: Dr. L. Douglas Smoot, 270 CB, Brigham Young University, Provo, Utah 84602. Included are the User's Manual and the card deck. The cost provides for some

assistance by telephone in implementing the code and interpreting the output.

26782 (IITRI-M—6043-6(QTPR)) **Design, engineering and evaluation of refractory liners for slagging gasifiers. Sixth quarterly technical progress report, No. M6043-6(QTPR).** Firestone, R.F.; Hales, C.; Greaves, M.J. (Oak Ridge National Lab., TN (USA)). Apr 1980. Contract AC05-78OR13410. 37p. NTIS, PC A03/MF A01.

Considerable research is required to establish optimum refractory system and design methods for slagging coal gasifiers. This program is a first attempt at the required research. While there have been a number of programs to test refractories for slagging gasifiers, there have been none which have tested more than a few small specimens of each refractory or closely simulated gasifier conditions. On this program, approximately 40 cu ft (over 600 9 in straight equivalents) of refractory will be tested during each run in the environment of a typical slagging gasifier. By testing this large amount of refractory, material variations are averaged out and a closer approximation to liners for large gasifiers is achieved. In addition, cooling system performance can be studied.

26783 (MLM—2728(OP)) **Instrumentation used for the monitoring and controlling of the Pricetown I underground coal gasification field test.** Zielinski, R.E.; Seabaugh, P.W.; Agarwal, A.K.; Liberatore, A.J.; Martin, J.W. (Mound Facility, Miamisburg, OH (USA); Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). 1980. Contract AC04-76DP00053. 11p. (CONF-800602—2). NTIS, PC A02/MF A01.

From Symposium on instrumentation and control for fossil energy processes; Virginia Beach, VA, USA (9 Jun 1980).

The instrumentation utilized for the Pricetown test accurately monitored process conditions as well as in-situ conditions. It provided for a continuous analysis of the product gas and integrated the test data for decision making and process control. The use of effective control algorithms also effectively minimized data collection but yet served to capture all process changes and other unanticipated data events.

26784 (SAN—13108-35) **Underground gasification for steeply dipping coal beds. Rawlins Test No. 1.** (Gulf Research and Development Co., Pittsburgh, PA (USA); TRW Energy Systems Planning Div., McLean, VA (USA)). Jan 1980. Contract AC03-77ET13108. 29p. NTIS, PC A03/MF A01.

The first US field test of gasification for a steeply dipping coal seam was recently completed under a cost-shared agreement with DOE with TRW as a major subcontractor. The project was developed utilizing the technology base provided by DOE in its other field tests and translations of the considerable Russian experiences. Rawlins No. 1 was clearly a success. Essentially all the objectives were met and much was learned about conducting the more complex Rawlins No. 2 field test. The test burn was on a tract on the eastern rim of the Continental Divide Basin. A 23 ft thick coal bed dipping at 63^0 was used to test the feasibility of using underground coal gasification techniques to extract energy from steeply dipping coal beds (UCG-SDB). The coal was ignited at a vertical depth of 400 ft utilizing a directionally drilled process well pair. The test was designed to investigate the effects of water/air injection, steam/air injection, and steam/oxygen injection. According to plan approximately 1200 tons of coal were utilized during the test. The heating value of the product gas initially climbed to approximately 180 Btu/SCF and, as expected, gradually declined to the 120 to 130 Btu/SCF range. A five-day steam/oxygen blown experiment was conducted subsequent to the steam/air phase. As expected, steam/oxygen injection easily doubled the product gas heating value to the 240 to 260 Btu/SCF range. A total of 28,000 ft^3 of coal had been utilized by the end of the test. The environmental studies concentrated on three major aspects: groundwater quality, air quality, and subsidence. (LTN)

26785 (SAND—79-2301) **Lateral transmission system for buried instrumentation.** Caffey, T.W.H.; Barnes, D.E.; Nidever, C.R.; Baughman, J.E. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 50p. NTIS, PC A03/MF A01.

A telemetry system that measures temperatures within a burning coal seam from beneath the seam is described. The temperature data are laterally transmitted through the earth to a receiver outside the high-temperature zone and then sent to the surface by wire. The system has a range of 46 m, battery capacity for 6-months operation, and performs 12 external measurements each hour. Complete electrical schematics together with ordering instructions for the fabrication drawing set are included in this report.

26786 (SAND—80-0745C) **Characterization of a potential underground coal gasification site in the state of Washington.** Bartel, L.C.; Dobecki, T.L.; Stone, R. (Sandia National Labs., Albuquerque, NM (USA); California Univ., Livermore (USA). Lawrence Livermore National Lab.). 1980. Contract AC04-76DP00789. 6p. (CONF-800806—23). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

Sandia Laboratories, Lawrence Livermore Laboratory, and the Laramie Energy Technology Center participated in a Department of Energy funded program to select and characterize a potential underground coal gasification test site in the State of Washington. A site in the Centralia-Chehalis coal district, satisfying certain criteria, was selected for characterization. The characterization procedures included surface and borehole techniques and hydrology tests. Geologic structure and coal seam structure and continuity were determined using surface geophysical prospecting (seismic and electromagnetic surveys) and borehole geophysical (logging and cross-borehole, in-seam seismic) techniques. A complete suite of geophysical logs was taken in eight exploratory boreholes to determine lithology and properties of the coal and surrounding strata. Coal cores taken from four different exploratory boreholes were analyzed to determine coal quality. Results of the characterization show that the coal seam of interest is approximately 47 ft thick at a depth of 570 to 600 ft at the site. The seam is characterized by high ash content, relatively low overall heating value, and a low permeability. The site appears suitable for conducting an underground coal gasification test.

26787 (SAND—80-1025) **Instrumentation and process control development for in situ coal gasification. Quarterly report, December 1979-March 1980.** Glass, R.E. (ed.). (Sandia Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 26p. NTIS, PC A03/MF A01.

The analysis of data for the Hanna IV and Hoe Creek in situ coal gasification tests raised questions concerning the fundamental controlling mechanisms of the process. The two main areas of concern are: (1) the air flow patterns; and (2) the initial cavity growth. Sandia National Laboratories is addressing these concerns by developing models of these processes. Results to date are in qualitative agreement with known phenomena. There have also been developments in data handling capability. These include improved data presentation ability and development of routine storage, access and back up methods.

26788 (SAND—80-1176C) **Buried telemetry system for in-situ energy extraction.** Barnes, D.E.; Caffey, T.W.H. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 8p. (CONF-800602—1). NTIS, PC A02/MF A01.

From Symposium on instrumentation and control for fossil energy processes; Virginia Beach, VA, USA (9 Jun 1980).

During an in-situ energy extraction process, a continuous knowledge of the temperature profile through the combustion area is desirable for analysis and control. To provide this data, a telemetry system has been developed that will monitor the thermocouples from beneath the process bed, digitize the data into 12 bit words and store them into memory. Every six hours, the stored data is transmitted laterally through the earth to a receiver outside of the high temperature zone and then sent to the surface by wire where it is stored on magnetic tape and processed and displayed on a Texas Instruments Silent 700 terminal.

26789 (SAND—80-1371C) **Role of UCG in maximizing coal utilization: site specific study.** Linn, J.K.; Love, S.L. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 7p. (CONF-800716—8). NTIS, PC A02/MF A01.

From 6. underground coal conversion symposium; Afton, OK, USA (13 Jul 1980).

The Department of Energy is sponsoring a project to develop a planning scheme for improving the utilization of coal deposits. This prototype study, called Total Economic Coal Utilization (TECU), is being applied to specific coal reserves within the Centralia-Chehalis District of Washington State. A significant aspect of the study is to determine the potential role for in situ gasification in maximizing the energy recovery and use. The results obtained indicate that UCG could be used to realize a sizeable increase in the amount of energy that can be economically recovered from the District. Since UCG technology has not reached the commercialization stage, some significant assumptions had to be made for this study. These are that the in situ process will work reliably and that product gas cleanup will proceed without major problems. However, if these conditions are met, this assessment indicates that in situ coal gasification could increase the extractable energy from Washington's Centralia-Chehalis coal deposits by a substantial amount and that this additional energy could be accessed at reasonable cost.

26790 (SAND—80-1402C) **Results of the characterization of an in situ coal gasification site in the state of Washington.** Bartel, L.C.; Dobecki, T.L.; Stone, R. (Sandia National Labs., Albuquerque, NM (USA); California Univ., Livermore (USA). Lawrence Livermore National Lab.). 1980. Contract AC04-76DP00789. 8p. (CONF-800716—6). NTIS, PC A02/MF A01.

From 6. underground coal conversion symposium; Afton, OK, USA (13 Jul 1980).

Sandia Laboratories, Lawrence Livermore Laboratory, and the Laramie Energy Technology Center participated in a Department of Energy funded program to select and characterize a potential underground coal gasification test site in the State of Washington. A site in the Centralia-Chehalis coal district, satisfying certain criteria, was selected for characterization. The characterization procedures included surface and borehole techniques and hydrology tests. Geologic structure and coal seam structure and continuity were determined using surface geophysical prospecting (seismic and electromagnetic surveys) and borehole geophysical (logging and cross-borehole, inseam seismic) techniques. A complete suite of geophysical logs was taken in eight exploratory boreholes to determine lithology and properties of the coal and surrounding strata. Coal cores taken from four different exploratory boreholes were analyzed to determine coal quality. Results of the characterization show that the coal seam of interest is approximately 47 ft thick at a depth of 570 to 600 ft at the site. The seam is characterized by high ash content, relatively low overall heating value, and a low permeability. The site appears suitable for conducting an underground coal gasification test.

26791 (SAND—80-1403C) **Tracer and air acceptance characterization of a San Juan basin coal.** Williams, F.L.; Nuttall, H.E.; Tyner, C.E.; Jacobson, R.D. (New Mexico Univ., Albuquerque (USA); Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 5p. (CONF-800716—7). NTIS, PC A02/MF A01.

From 6. underground coal conversion symposium; Afton, OK, USA (13 Jul 1980).

As part of an ongoing effort to develop and assess the feasibility of underground coal gasification in New Mexico, a field study was performed to determine the natural flow characteristics of an undisturbed coal seam. Dewatering, air injection, and tracer experiments were conducted on a two-hole test pattern, spaced 30 ft apart, in a 15-ft-thick seam located about 500 ft below the surface. This was the first field experiment in coal to utilize a newly developed downhole measuring system designed and operated by Sandia National Laboratories. From the tracer flow logs and air acceptance tests it was found that the formation allows gas flow (100 SCFM at 250 psi) with low water production (50 gpd). While some vertical variation in air flow and tracer residence time through the coal seam was found, all of the coal sustained flow through a relatively low volume of active voids. Only 10 percent of the injected air was recovered and the recovery rate paralleled trends in the injection rate.

26792 (UCRL—50026-79-4) **LLL in situ coal gasification project. Quarterly progress report, October-December 1979.** Cena, R.J.; Strack, B.S. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Apr 1980. Contract W-7405-ENG-48. 40p. NTIS, PC A03/MF A01.

The major effort this quarter has been postexperiment analysis of Hoe Creek No. 3 and planning for future gasification experiments. Hoe Creek No. 3: Thermal data have been analyzed to determine the performance of the drilled horizontal channel during forward gasification. Thermal and material balance data are combined to determine late-time burn boundaries for the experiment. Surface subsidence after the experiment was completed is described. Process wells were inspected to determine failure characteristics and pinpoint late-time injection location. Ground-water quality before and after Hoe Creek No. 3 and the effects of aquifer interconnection on hydraulic measurements at the Hoe Creek No. 2 and No. 3 sites are discussed. Future experiments: Potential UCG sites are being characterized for future tests. Two sites in the Powder River Basin near Gillette, Wyoming are discussed. Preliminary plans for a deep site gasification experiment and a new method for in situ gasification of thick seams are presented.

26793 (UCRL—83961) **Results from the third LLL underground coal gasification experiment at Hoe Creek.** Hill, R.W.; Thorsness, C.B.; Cena, R.J.; Aiman, W.R.; Stephens, D.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 May 1980. Contract W-7405-ENG-48. 12p. (CONF-800716—3). NTIS, PC A02/MF A01.

From 6. underground coal conversion symposium; Afton, OK, USA (13 Jul 1980).

A major objective of the US Energy Program is the development of processes to produce clean fuels from coal. Underground coal gasification is one of the most promising of these processes. If successful, underground coal gasification (UCG) would quadruple the proven reserves of the US coal. Cost for products produced from UCG are projected to be 65 to 75% of those from conventional coal conversion. Finally, UCG appears to possess environmental advantages since no mining is involved and there are less solid wastes produced. In this paper we describe results from the Hoe Creek No. 3 underground coal gasification test. The experiment employed a drilled channel between process wells spaced 130' apart. The drilled channel was enlarged by reverse combustion prior to forward gasification. The first week of forward gasification was carried out using air injection, during which 250 tons of coal were consumed yielding an average dry product gas heating value of 114 Btu/scf. Following this phase, steam and oxygen were injected (generally a 50-50 mixture) for 47 days, during which 3945 tons of coal were consumed at an average rate of 84 tons of coal per day and an average dry gas heating value of 217 Btu/scf. The average gas composition during the steam-oxygen phase was 37% H_2, 5% CH_4, 11% CO, and 44% CO_2. Gas recovery was approximately 82% during the test, and the average thermochemical efficiency was near 65%.

26794 (UCRL—84084) **Environmental aspects of the proposed UCG project site in Washington state.** Adamson, M.; Tonnessen, K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 May 1980. Contract W-7405-ENG-48. 6p. (CONF-800716—4). NTIS, PC A02/MF A01.

From 6. underground coal conversion symposium; Afton, OK, USA (13 Jul 1980).

Lawrence Livermore National Laboratory is conducting an environmental assessment of the proposed underground coal gasification experiment in the Tono Basin near Centralia, Washington. This analysis is funded by the Department of Energy. To satisfy the provisions of the National Environmental Policy Act (NEPA), the following elements are included in the assessment: (1) description of the proposed action and alternatives; (2) description of the existing environment; (3) potential environmental impacts of the project; and (4) agencies consulted to ensure coordination in evaluating effective mitigation measures. Field reconnaissance and environmental data collected from both state and county agencies and from local individuals and organizations form the basis for an evaluation of the potential impact of the project on this riparian ecosystem. A cultural resource survey was also conducted as part of the site evaluation. Principal areas of concern include the potential for damage due to air emissions and groundwater contamination, maintenance of surface water quality and minimization of disruption of wildlife habitat. Possible mitigation measures to protect environmental quality are recommended.

26795 (UCRL—84458) **Gasification of coal with solar energy.** Aiman, W.R.; Gregg, D.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1980. Contract W-7405-ENG-48. 28p. (CONF-800610—8). NTIS, PC A03/MF A01.

From American Institute of Chemical Engineering conference; Philadelphia, PA, USA (8 Jun 1980).

Focused solar energy can be used to drive the endothermic reactions that gasify coal. The economics are attractive. Coal resources are conserved. Coal reactors are adaptable to solar-energy facilities. Two advantages make solar coal gasification attractive economically. First, synthesis gas (a nitrogen-free product) can be produced without pure oxygen which is expensive. Second, for a given amount of product only half as much coal is required. A disadvantage is that the solar energy is available only about 8 hours per day; therefore, post-gasification processing units must be oversized and equipped for rapid startup and shutdown. This disadvantage is balanced by the 50% reduction cost for coal and coal pretreatment equipment and in the sulfur content of the product gas. A number of gasification reactors are discussed including a moving bed reactor; a fluidized bed reactor; a closed-loop, heat-transfer-fluid reactor; and an open-loop, heat-transfer-fluid reactor. A model of solar coal gasification is discussed and used to reinterpret the results of a field experiment in solar coal gasification. The expected performance of a moving-bed gasifier will yield products with an energy content 25% higher than the initial coal compared to 17% higher for a fixed-bed gasifier. The model also allowed estimation of various other quantities not measured in the experiment such as tar and char production, steam requirements, and all of the energetics of the process.

26796 **Ammonia from coal.** Waitzman, D.A.; Nichols, D.E.; Alves, G.W.; Hyland, M.J. pp 15p, Paper 25 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The Tennessee Valley Authority (TVA) Ammonia from Coal Project will replace natural gas as feedstock for ammonia. Plant retrofitting is scheduled to begin in 1980 at TVA's Muscle Shoals, Alabama demonstration plant, which will use the Texaco partial oxidation process to gasify coal. The plant is designed to use several types of coal, with Illinois No. 6 coal setting the design conditions. A summary is given of temperature and pressure requirements for gasification, downstream processing, and plant and ammonia production costs. Data from the TVA Demonstration Plant will be used to improve design and cost estimate accuracy to establish the cost effectiveness of ammonia from coal. (DCK)

26797 (UCRL-Trans—11589) **First experiment on underground coal gasification with a directed flow supply in the plane of the coal seam.** Leonovich, M.M.; Volk, A.F. Translated from *Podzemn. Gazif. Uglei;* No. 3, 47-52(1958). 21p. NTIS, PC A02/MF A01.

During the experiment 2350 tons of coal were gasified. The average heating value of the gas over the entire operating period was 915 kcal/nm³. In the course of the experiments with a directed flow supply for gasification, the temperature of the exhaust gases was 100 to 150°C lower than the gas temperature in the gas-outlet boreholes of gas generators of the Moscow Podzemgaz Station with ordinary flow supply. The exhaust gas temperature during directed flow supply decreases mainly for two reasons: first, as a result of more complete occurrence of the reduction reactions; and second, on a comparatively short section en route to the gas outlet, the gas formed yields part of its physical heat to heating of the country rock around the coal seam, and to drying the coal in the crosslinking channel. This in turn creates favorable conditions for reduction reactions in the gasification channel, given chance disruptions of the gasification process on the concave contour. In contrast to the previous experiment, where significant subsidence of the coal seam roof occurred during coal gasification according to survey data, there was no shifting of the earth's surface either during this experiment or for a long time afterwards. By comparing the results of the experiments on elongated channels, it is not difficult to satisfy oneself that practically equivalent process indices were obtained with different behavior of the coal seam roof. Consequently, experimental work with a directed flow supply in the coal seam plane has confirmed the feasibility of controlling the gasification process by aerodynamic means and, to a significant degree, independently of the behavior of the coal seam roof.

LIQUEFACTION

REFER ALSO TO CITATION(S) 26768, 26803, 26810, 26811, 27442, 27443, 27444

26798 (CONF-800610—7) **Hydrogen exchange in some coal-related reactions at 400°C.** Benjamin, B.M.; Michalczyk, M.J.; Woody, M.C. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 12p. NTIS, PC A02/MF A01.

From American Institute of Chemical Engineering conference; Philadelphia, PA, USA (8 Jun 1980).

Data are available for kinetics of the transfer of hydrogen from tetralin and other hydrogen-rich solvents, but not much is known about the detailed mechanism involving individual linkages or groups in coal. In order to obtain some of this information, we have chosen to work with the pure compounds, 1,2-diphenylethane (bibenzyl), and diphenylmethane as models for certain linkages in coal. Because the thermolysis of the compound gives some different products when heated alone or when heated in the presence of a good hydrogen donor, such as tetralin, it was of interest to know where the cleavage fragments derive their hydrogen to give the final product. While the source of hydrogen needed to cap off the thermolysis fragments is obvious when bibenzyl is heated alone, its origin is ambiguous when tetralin is present. In order to resolve this aspect of the reaction, we prepared bibenzyl completely deuterated (99.8%) in the dimethylene linkage, and pyrolyzed it in the presence of ordinary tetralin. The products were isolated and their hydrogen and deuterium content were determined. From the data we conclude that the benzyl radical, formed by cleavage of bibenzyl, gives toluene by abstracting hydrogen from tetralin. The product after 1 percent conversion was $PhCD_2H$. Further, it was observed that, upon heating the mixture for eight hours, deuterium appeared in all the compounds. A considerable amount of deuterium exchange had taken place. In fact, in this mixture, tetralin-bibenzyl-d_4 at 400°C, deuterium is lost from bibenzyl by exchange 3 to 4 times faster than it undergoes carbon-carbon bond scission. Thus, the chemistry of bibenzyl at 400° is dominated by hydrogen exchange reactions.

26799 (DOE/ET/13557—19) **Report on SARS backfit evaluation, Catalytic, Inc. Solvent Refined Coal Pilot Plant, Wilsonville, Alabama.** Meyer, A.F. Jr. (Meyer (A.F.) and Associates, Inc., McLean, VA (USA)). 2 Jul 1980. Contract AC02-79ET13557. 37p. NTIS, PC A03/MF A01.

A site visit was made in company with the DOE-OPTA-EA Safety and Health Official for the purpose of providing that official with technical assistance in evaluating the validity of an earlier DOE-OPTA recommendation exempting this facility from the Safety and Analysis and Review backfit requirements of DOE Order 5481.1. A further purpose of the visit was to assess and evaluate the occupational safety and health program at this facility, as compared with the criteria and guidelines contained in ASFE Order 5481.1. Adequate documentation regarding compliance with codes, standards, and regulations were observed at this facility. There is in existence an ongoing continuous safety analysis effort for both modifications or additions to this facility. Adequate environmental safeguards and plans and procedures were observed. The SARS backfit exemption is appropriate. The occupational safety and health program is in many ways a model for the scope of work and nature of hazards involved, and is consistent with ASFE guidelines and statutory requirements.

26800 (DOE/ET/14503—1) **Development of a correlation between slurry oil composition and process performance. Topical report 1. Analyses of slurry recycle oils from H-Coal PDU Run 5.** Burke, F.P.; Winschel, R.A.; Pochapsky, T.C. (Conoco Coal Development Co., Library, PA (USA). Research Div.). Apr 1980. Contract AC05-79ET14503. 74p. NTIS, PC A04/MF A01.

Daily samples of the slurry recycle oil from the 30-day H-Coal PDU Run 5 (Syncrude mode, Illinois 6 coal) were analyzed by ^{1}H-NMR spectroscopy GS/MS, and liquid chromatographic techniques. The recycle oils composition in PDU Run 5 reached an initial steady-state at about day 12, but this was upset when the hydrogen partial pressure was increased on day 20. The recycle oil composition was again approaching a steady-state by the end of the run. The distillates increased in aromaticity during the first 12 days of the run, as catalyst activity declined. The more aromatic distillates are better liquefaction media. Therefore, the solvent quality of the recycle distillates improved as the run progressed. The recycle distillates boiling below phenanthrene consist largely of cracking and isomerization products of hydrophenanthrenes. The relative ratios of reactants and products may be useful in establishing catalyst activity during the run. The start-up solvent had little effect on the run, because it was rapidly replaced by coal-derived recycle oils. The molecular weight distribution of the recycle resid (975°F$^+$, THF soluble) was relatively unchanged during the run although the ratio of benzene solubles to insolubles first decreased as catalyst activity declined, then increased with the increased hydrogen partial pressure during the last ten days of the run.

26801 (ORNL/TM—7327) **Analysis of T-105 Fractionation Column failure at the Wilsonville, Alabama, Solvent Refined Coal (SRC) pilot plant.** Baylor, V.B.; Keiser, J.R.; Leslie, B.C.; Allen, M.D.; Swindeman, R.W. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 50p. NTIS, PC A03/MF A01.

The T-105 Fractionation Column at the Wilsonville, Alabama, Solvent Refined Coal (SRC) pilot plant was removed from service in February 1979, when corrosion had exceeded design limits. Inspection revealed general thinning of vessel walls and internal components as well as pitting and localized attack in weld heat-affected zones. On-site metallography also revealed some intergranular attack of the vessel wall. Metallographic and microprobe examination showed the corrosion scale on austenitic stainless steels to be predominantly nickel sulfide. Chemical analysis of the process fluids revealed that the amount of chlorine in the column feed was substantially greater than that measured before a change was made in the type of coal being processed. We suspect that the corroding species was a sulfur-containing organic acid whose attack was accelerated by the presence of chlorides; however, the offensive agent has yet to be positively identified. Laboratory work aimed at identifying the corrosion mechanism is continuing.

PYROLYSIS AND CRACKING

26802 (DOE/ET/13153—T2) **Short residence time hydropyrolysis of coal. Technical progress report, 1 January-31 March 1980.** Saville, D.A.; Russel, W.B. (Princeton Univ., NJ (USA). Dept. of Chemical Engineering). 1980. Contract AC01-79ET13153. 23p. NTIS, PC A02/MF A01.

This report sets forth the current status of our efforts to model the hydropyrolysis process on the scale of a single coal particle. Several oversimplifications of the original model have been identified and the more general analysis begun. As emphasized in the literature, the effect of time-temperature history, or nonisothermal reaction conditions, appears to be important and is being incorporated into the model. An increased internal pressure due to the restricted escape of volatiles can increase the rate of deposition and also cause the swelling of plastic coal particles. Our efforts reported here should lead to realistic descriptions of these processes.

PROPERTIES

REFER ALSO TO CITATION(S) 26776, 26793, 26797

26803 (DOE/LC/01761—T1) **Separation and determination of polycyclic aromatic hydrocarbons and nitrogen heterocycles pertaining to coal gasification, tar sands, shale oil, coal liquids, and related samples. Final technical progress report, January 1978-December 1979.** Hurtubise, R.J. (Wyoming Univ., Laramie (USA). Dept. of Chemistry). 1979. Contract AS20-79LC01761. 63p. NTIS, PC A04/MF A01.

A method was developed for identifying and determining benzo[a]pyrene in a filtered retort water sample from an in situ oil shale process by employing liquid-liquid extraction, dry-column

chromatography, thin-layer chromatography and fluorescence spectrometry. The accuracy and precision of the method were good, and the limit of detection was approximately 0.08 ppB. Irreproducible results were obtained with unfiltered retort water samples. Programmed multiple development was used to a limited extent in the separation of polycyclic aromatic hydrocarbons from a shale oil sample. However, results indicated that this separation technique should be investigated further in the separation of polycyclic aromatic hydrocarbons. Benzo[a]pyrene was determined in several shale oil samples by methods developed previously. Polycyclic aromatic hydrocarbons were characterized in several shale oil samples using open-column, dry-column and thin-layer chromatography as separation steps. Visible fluorescence from the separated components on chromatoplates was measured directly to obtain fluorescence profiles of the components on the chromatoplates. Several comparisons were made among the shale oil samples as to the relative amounts of 6-, 5-, 4- and 3-ring polycyclic aromatic hydrocarbons. The theoretical and practical analytical aspects of the room temperature phosphorescence of nitrogen heterocycles were investigated. Intense room temperature phosphorescence was obtained from several nitrogen heterocycles when these compounds were absorbed on silica gel. Theoretical explanations were given for the intense phosphorescence. Benzo[f]quinoline and phenanthridine were separated from a shale oil sample by open-column and high performance liquid chromatography, and then identified by room temperature phosphorescence.

26804 (LA-UR—80-585) **Statistical validity for electron probe microanalysis of organic sulfur in coal.** Raymond, R. Jr.; Davies, T.D.; Hagan, R.C. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 7p. (CONF-800815—2). NTIS, PC A02/MF A01.

From Microprobe Analytical Society conference; San Francisco, CA, USA (Aug 1980).

It is shown that EPM of a relatively few vitrinite grains gives a good representation of the organic sulfur content of the entire vitrinite population. The use of photomosaics is not needed in order to provide statistically valid data. (DLC)

26805 (LA-UR—80-1625) **Infrared analysis of coal gasifier product gases.** Holland, R.F.; Quigley, G.P.; Vasquez, M.C. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 11p. (CONF-800602—6). NTIS, PC A02/MF A01.

From Symposium on instrumentation and control for fossil energy processes; Virginia Beach, VA, USA (9 Jun 1980).

Infrared absorption measurements using a Fourier transform infrared spectrometer have been found to be a convenient way to measure the concentration of certain infrared-absorbing gases always present in a coal gasifier product stream. In this paper, we describe preliminary measurements using this technique with gas mixtures representative of gasifier products in high pressure, statically filled cells. No attempt was made at this point to simulate the actual gasifier environment vis-a-vis anticipated particulate loading problems.

26806 (LA-UR—80-1680) **Modeling and interpretation of two-phase flow and tracer studies from a subbituminous coal seam in the San Juan basin of New Mexico.** Nuttall, H.E.; Travis, B.J. (New Mexico Univ., Albuquerque (USA). Dept. of Chemical Engineering; Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 10p. (CONF-800716—9). NTIS, PC A02/MF A01.

From 6. underground coal conversion symposium; Afton, OK, USA (13 Jul 1980).

Field and modeling studies were performed to characterize two-phase flow within the natural cleat structure of an upper Cretaceous subbituminous coal seam. A two borehole pattern with open completion was used in a study of dewatering and tracer residence time distribution. Air was pumped into a five meter thick seam located about 170 meters below the surface. Krypton 85 was used as the airborne tracer. Air inflow and air and water production rates and tracer arrival times were monitored. The field tests were simulated with a two-phase, three component, porous flow code. Results showed that the air inflow and air and water outflow rates and breakthrough times could not be modeled assuming a uniform darcy-type permeability. The use of a pressure dependent permeability did provide, however, a much better match with the field data.

26807 **Molecular structure of coal.** Davidson, R.M. London, England; IEA Coal Research (1980). 86p. (ICTIS/TR—08).

Recent literature (mainly post-1973) on studies relating to the elucidation of the molecular structures present in coal is reviewed. The topics covered include the estimation of the molecular weight distribution of coal fragments; the estimation of the carbon aromaticity values; the identification of the aromatic ring structures present; studies on the aliphatic part of the structure; the identification of low molecular weight compounds trapped in the coal matrix; the structural evidence arising from electron spin resonance studies of free radicals in coal; and the nature of functional groups and heteroatoms (oxygen, sulfur, nitrogen). Changes in structural parameters with increasing coal rank and models of the total macromolecular skeletal structure are considered. It is concluded that, despite the recent accumulation of new facts, a coherent picture of the organic structure of coal is yet to emerge. 171 references.

26808 **Compatible mixtures of coal liquids and petroleum based fuels.** Cabal, A.V.; Bendoraitis, J.G.; Callen, R.B.; Pavlica, R.T.; Voltz, S.E. (to Electric Power Research Inst., Inc.). US Patent 4,178,226. 11 Dec 1979. Filed date 15 Apr 1977. 4p.

Enhanced compatibility of coal liquids with petroleum based fuels is achieved by removing or modifying the 950°F plus asphaltene-containing fraction of the coal liquid. The separation or modification can be achieved by distillation, deasphalting, hydroprocessing, and the like.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 26773

26809 (CONF-800334—13) **Leaching studies of coal gasification solid waste to meet RCRA requirements for land disposal.** Tamura, T.; Boegly, W.J. Jr. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 19p. NTIS, PC A02/MF A01.

From 2. DOE environmental control symposium; Reston, VA, USA (17 Mar 1980).

The purpose of this paper is to describe the research currently underway at ORNL related to the land disposal of coal gasification ash. Included are data on the chemical composition and properties of ash from five of six proposed gasification/liquefaction demonstration plants and of several selected soils. Batch leaching results are presented which determine compliance with RCRA, along with other suggested batch leaching procedures. Leaching studies with ash/soil columns are also presented. The ultimate goal of this study is to provide design information and procedures to insure that solid wastes from gasification plants will comply with RCRA regardless of whether the waste is classified as hazardous or non-hazardous.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 26770, 26794, 27668, 27669, 27670, 27671, 27675, 27680, 27683, 27684, 27732, 27739, 27913, 27921, 27935, 27936, 27937, 27939, 27940, 27941, 27942, 27943, 27944, 27945

26810 (CONF-800559—1) **Coal conversion siting on coal mined lands: water quality issues.** Triegel, E.K. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 15p. NTIS, PC A02/MF A01.

From International federation of automatic control symposium on water and related resources systems; Cleveland, OH, USA (28 May 1980).

The siting of new technology coal conversion facilities on land disturbed by coal mining results in both environmental benefits and unique water quality issues. Proximity to mining reduces transportation requirements and restores disrupted land to productive use. Uncertainties may exist, however, in both understanding the existing site environment and assessing the impact of the new technology. Oak Ridge National Laboratory is currently assessing the water-related impacts of proposed coal conversion facilities located in areas disturbed by surface and underground coal mining. Past mining practices, leaving highly permeable and unstable fill, may affect the design and quality of data from monitoring programs. Current mining and dewatering, or past underground mining may alter groundwater or surface water flow patterns or affect solid waste disposal stability. Potential acid-forming material influences the siting of waste disposal areas and the design of grading operations. These and other problems are considered in relation to the uncertainties and potentially unique problems inherent in developing new technologies.

26811 (COO—4574-1) **Criteria for the development and use of the methodology for environmentally-acceptable fossil energy site evaluation and selection. Volume 2. Final report.** Eckstein, L.; Northrop, G.; Scott, R. (Cameron Engineers, Inc., Denver, CO (USA); Center for the Environment and Man, Inc., Hartford, CT (USA); Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Research Center). 1 Feb 1980. Contract EY-77-C-02-4574. 289p. NTIS, PC A13/MF A01.

This report serves as a companion document to the report, Volume 1: Environmentally-Acceptable Fossil Energy Site Evaluation and Selection: Methodology and Users Guide, in which a methodology was developed which allows the siting of fossil fuel conversion facilities in areas with the least environmental impact. The methodology, known as SELECS (Site Evaluation for Energy

Conversion Systems) does not replace a site specific environmental assessment, or an environmental impact statement (EIS), but does enhance the value of an EIS by thinning down the number of options to a manageable level, by doing this in an objective, open and selective manner, and by providing preliminary assessment and procedures which can be utilized during the research and writing of the actual impact statement.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 26790, 26791, 27996

MINING

26812 (DOE/ET/12200—T1) **State-of-the-art study of resource characterization and planning for underground coal mining. Final technical report as of June 30, 1980.** Walton, D.; Ingham, W.; Kauffman, P. (Management Engineers, Inc., Reston, VA (USA)). Jun 1980. Contract AM01-77ET12200. 133p. NTIS, PC A07/MF A01.

With the rapid developments taking place in coal mining technology and due to high investment costs, optimization of the structure of underground coal mines is crucial to the success of the mining project. The structure of a mine, once it is developed, cannot be readily changed and has a decisive influence on the productivity, safety, economics, and production capacity of the mine. The Department of Energy desires to ensure that the resource characterization and planning activity for underground coal mining will focus on those areas that offer the most promise of being advanced. Thus, this project was undertaken by Management Engineers Incorporated to determine the status in all aspects of the resource characterization and planning activities for underground coal mining as presently performed in the industry. The study team conducted a comprehensive computerized literature search and reviewed the results. From this a selection of the particularly relevant sources were annotated and a reference list was prepared, catalogued by resource characterization and mine planning activity. From this data, and discussions with industry representatives, academia, and research groups, private and federal, an assessment and evaluation was made of the state-of-the-art of each element in the resource characterization and mine planning process. The results of this analysis lead to the identifcation of areas requiring research and, specifically, those areas where DOE research efforts may be focused.

26813 (DOE/TIC—3381) **Coal production expansion: a selected bibliography.** Grissom, M.C. (ed.). (Department of Energy, Oak Ridge, TN (USA). Technical Information Center). Jul 1980. 57p. NTIS, PC A04/MF A01.

The expeditious and economic transport of coal from producing regions to consuming regions is essential to any policy designed to increase the use of coal as an energy source. Obtaining an optimal coal transportation system, including terminal facilities, is significant in providing US coal to its users in the United States and abroad. Rail, barge, truck, slurry pipeline, and ship are the modes used to move coal from the producer to the user. Transportation costs represent a large percentage of the delivered price. This bibliography includes 138 selected citations on coal export, transport, and production. The references are to reports from the Department of Energy and its contractors, reports from other government or private organizations, and journal articles, books, conference papers, and monographs from US originators. These citations and hundreds of additional citations on this subject are available for on-line searching and retrieval from the Technical Information Center's Energy Data Base using the DOE/RECON interactive system. Approximately 50,000 citations on coal and coal products are a part of this data base. Current additions to data base on this subject are announced monthly in Fossil Energy Update. DOE-sponsored work is also announced in Energy Research Abstracts. The citations in this publication are arranged in broad subject categories as shown in the table of contents. Five indexes are provided: Corporate, Author, Subject, Contract Number, and Report Number. Included as an appendix are some tables and figures from Energy Information Administration reports covering coal production and disposition.

26814 (FE—8922-2(Vol.1)) **Development of operational aids for improved shovel utilization. Final technical report.** Keller, K.J.; Nelson, B.D.; Woodruff, W.C. (McDonnell Douglas Electronics Co., St. Charles, MO (USA)). Apr 1980. Contract AC01-76ET12201. 71p. NTIS, PC A04/MF A01.

This report contains the results of a study on the application of on board computer display and recording system to shovels used in coal mining. In addition to this study a computer simulation model of a shovel was developed and used to evaluate the effect of various parameters associated with shovel operation. Volume I contains a description of on board systems recommended for loading and stripping shovels. Also in Volume I is a description of the simulation model. Volume II is a system manual for the shovel simulation program.

26815 (FE—8922-2(Vol.2)) **Development of operational aids for improved shovel utilization. System manual for shovel computer simulation model. Final technical report.** Keller, K.J.; Nelson, B.D.; Woodruff, W.C. (McDonnell Douglas Electronics Co., St. Charles, MO (USA)). Apr 1980. Contract AC01-76ET12201. 112p. NTIS, PC A06/MF A01.

This report contains the results of a study on the application of on board computer display and recording system to shovels used in coal mining. In addition to this study a computer simulation model of a shovel was developed and used to evaluate the effect of various parameters associated with shovel operation. Volume I contains a description of on board systems recommended for loading and stripping shovels. Also in Volume I is a description of the simulation model. Volume II is a system manual for the shovel simulation program.

26816 (FE—8922-3(Vol.2)) **Development of operational aids for improved dragline utilization: system manual for dragline computer simulation model. Final technical report.** Keller, K.J.; Thorn, J.S. (McDonnell Douglas Electronics Co., St. Charles, MO (USA)). Apr 1980. Contract AC01-76ET12201. 388p. NTIS, PC A17/MF A01.

The computer simulator model developed under DOE contract ET-76-C-01-8922 was modified to simulate extended bench and pullback procedures. Volume I of this report outlines the modifications made to the simulation model and the results of a simulation study of extended bench and pullback procedures. Volume II is a revision of the system manual for the simulation model.

26817 (JPL-PUB—79-122) **Economic baselines for current underground coal mining technology. Final report.** Mabe, W.B. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Dec 1979. Contract AI01-76ET12548. 68p. NTIS, PC A04/MF A01.

This report describes the calculations of the cost of mining coal using a room and pillar mining method with continuous miner and a longwall mining system. The costs were calculated for the 1975 and year 2000 time periods and are to be used as economic standards against which advanced mining concepts and systems will be compared. The calculations procedure used was generated by the NUS Corporation for the Electric Power Research Institute under contract RP 435-1. However, some assumptions were changed and some internal model-stored data were altered to obtain a result that more closely represented what was considered to be a standard mine. Coal seam thicknesses were varied from one and one-half feet to eight feet to obtain the cost of mining coal over a wide range. Geologic conditions were selected that had a minimum impact on the mining productivity.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 26764, 26777, 26813

26818 (DOE/ET/10045—T1) **Analysis of chemical coal cleaning processes. Final report.** (Bechtel National, Inc., San Francisco, CA (USA)). Jun 1980. Contract AC01-78ET10045. 201p. NTIS, PC A10/MF A01.

Six chemical coal cleaning processes were examined. Conceptual designs and costs were prepared for these processes and coal preparation facilities, including physical cleaning and size reduction. Transportation of fine coal in agglomerated and unagglomerated forms was also discussed. Chemical cleaning processes were: Pittsburgh Energy Technology Center, Ledgemont, Ames Laboratory, Jet Propulsion Laboratory (two versions), and Guth Process (KVB). Three of the chemical cleaning processes are similar in concept: PETC, Ledgemont, and Ames. Each of these is based on the reaction of sulfur with pressurized oxygen, with the controlling factor being the partial pressure of oxygen in the reactor. All of the processes appear technically feasible. Economic feasibility is less certain. The recovery of process chemicals is vital to the JPL and Guth processes. All of the processes consume significant amounts of energy in the form of electric power and coal. Energy recovery and increased efficiency are potential areas for study in future more detailed designs. The Guth process (formally designed KVB) appears to be the simplest of the systems evaluated. All of the processes require future engineering to better determine methods for scaling laboratory designs/results to commercial-scale operations. A major area for future engineering is to resolve problems related to handling, feeding, and flow control of the fine and often hot coal.

26819 (FE—3184-1) **Investigation and analysis of frozen coal handling problems.** (Energy Interface Associates, Palos Verdes Estates, CA (USA)). Nov 1979. Contract ET-78-C-01-3184. 134p. NTIS, PC A07/MF A01.

This report covers the unusual difficulties experienced during the winters of 1976 to 1977 and 1977 to 1978 and the actions of the

affected coal producers, transporters and users to alleviate future problems. A brief description of the two winters' weather for selected areas is included. Our investigations found that public utilities and other users and processors are responding to the problems. They have instituted winterization of plant equipment and have added chemicals at the mines that can reduce the severity of frozen coal. However, continued research into the mechanics of coal agglomeration is needed to find viable freezeproofing techniques. The objective of this report is to define the nature and extent of frozen coal handling and burning problems at generating stations, mine sites and transfer points. Site surveys consisted of visits to 13 power plants or utility power companies representing approximately 60 coal-fired electrical generating stations, four mine sites and six transfer points. The specific problems at each site were investigated. Discussions with operating and management personnel emphasized corrective actions in effect or being considered. The final task was to present technically and economically feasible solutions and to present viable areas of research to alleviate problems with frozen coal.

26820 (FE—3242-40) **Laminar flow cyclone development program. Quarterly technical progress report, 1 January-31 March 1980.** Giles, W.B. (General Electric Co., Schenectady, NY (USA)). Apr 1980. Contract AC21-78ET11031. 22p. NTIS, PC A02/MF A01.

The principal constraint to high Reynolds number operation is due to boundary layer instability in the radial inflow region. Therefore, a modified model has been built to study the influence of inlet wall heating with the water flow model. This wall heated model of the radial inflow region has been adapted with additional thermocouples, plus insulation of the rim. The data continue to indicate highly stable flow conditions up to the maximum test Reynolds numbers. Work is continuing to further increase the system flow rate.

26821 (LA-UR—80-1526) **Kinetic and equilibrium measurements of coal drying.** Heller, A.; Elliott, G.R.B. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 7p. (CONF-800716—5). NTIS, PC A02/MF A01.

From 6. underground coal conversion symposium; Afton, OK, USA (13 Jul 1980).

The retention, attachment, and release of water (sorption, adsorption, and desorption) in Fruitland subbituminous coal are shown to be very complex phenomena. The vapor pressure and thermodynamic activity of water in the coal at about 315 K vary sharply with composition. Removal of 60% of the water initially present reduces the vapor pressure by about 60%. The total moisture content of saturated coal also varies with temperature. A 10 K rise in temperature reduces the sorbed water by about 8%. There is strong hysteresis in the sorption behavior; water which is desorbed by reducing the vapor pressure over a coal sample is not fully replaced by adsorption when the vapor pressure is returned to its original level. These measurements of desorption and adsorption reflect stable and metastable equilibria. Kinetic measurements are reported for approach to a new equilibrium if the vapor pressure over the coal is reduced. The kinetic measurements reflect the shape of the pores while equilibrium vapor pressures reflect how tightly the water is bound in the pores. Both types of measurement show changes in behavior at the same compositions. Implications of these results for UCG are discussed.

COMBUSTION

REFER ALSO TO CITATION(S) 26764, 26820, 27198, 27617, 27618, 27619, 27620, 27621, 27622, 27623

26822 (CONF-7906157—) **Pressurized fluidized-bed combustion technology exchange workshop.** (Department of Energy, Washington, DC (USA). Div. of Fossil Fuel Utilization). Apr 1980. 218p. NTIS, PC A10/MF A01.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

The pressurized fluidized-bed combustion technology exchange workshop was held June 5 and 6, 1979, at The Meadowlands Hilton Hotel, Secaucus, New Jersey. Eleven papers have been entered individually into EDB and ERA. The papers include reviews of the US DOE and EPRI programs in this area and papers by Swedish, West German, British and American organizations. The British papers concern the joint program of the USA, UK and FRG at Leatherhead. The key factor in several papers is the use of fluidized bed combustors, gas turbines, and steam turbines in combined-cycle power plants. One paper examines several combined-cycle alternatives. (LTN)

26823 (CONF-7906157—, pp 15-47) **AEP/STAL-Laval pressurized fluidized bed combustion program: report on Phase II.** Markowsky, J.J. (American Electric Power Service Corp., New York, NY); O'Connell, L.P.; Wickstrom, B.; Jansson, S.A. Apr 1980.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

The AEP/STAL-Laval program and the Phase II activities are designed to provide the technical and economic information required to evaluate the practicality of utilizing PFBC for electric power generation. This approach is thought to be both prudent and expedient in order to commercialize PFBC in a timely fashion. Today, utilities must consider several highly variable factors while planning new generation. These factors include environmental and site restrictions, high cost of capital, uncertain load growth projections and continued escalation of power plant and fuel costs. The PFBC technology addresses these issues in that it has proven to meet or exceed EPA's proposed new source performance standards, its capital cost and construction time is lower in comparison with projected to be current technologies. In addition, the 500 MW PFBC plant allows a rapid response to load growth requirements because of its shorter construction time and standardized design. The PFBC technology while addressing many of the variables that utilities face today, also has good potential for cycle efficiency improvements. This feature will increase the attractiveness of PFBC as coal price continues to escalate.

26824 (CONF-7906157—, pp 48-53) **PFBC development program of the Arbeitsgemeinschaft Wirbelschichtfeuerung (AGW).** Schreckenberg, H.; Bonn, B.; Schilling, H.G. (Bergbau-Forschung, Essen, Germany). Apr 1980.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

Sponsored by the German Federal Minister of Research and Technology a research project got underway in 1976 with the target of establishing the basic engineering for a combined gas/steam turbine power plant with PFBC. To gather sufficient know-how and experience, AGW runs a laboratory to investigate the combustion fundamentals and to test various coals and limestones. Tests have been made at both atmospheric and elevated pressures to evaluate the influence of pressure as an important operation parameter. For the systematic investigation of the parameters of influence on the chemical reactions in FBC, the laboratory research program has been subdivided into three main series. (1) Evaluation of the influence of operation parameters on combustion efficiency and the release of pollutants while using standard coal and limestone. (2) Study of the effect of using different coals on combustion efficiency and emissions at standardized operation conditions and feeding standard limestone. (3) Testing of various limestones with respect to their desulfurization efficiency at standard operation conditions and feeding standard c al. Since the realization of te Brayton cycle plays the key role for establishing a gas/steam turbine combined cycle, the main activity concentrates on the design and construction of a gas turbine plant with PFBC.

26825 (CONF-7906157—, pp 54-70) **Development of pressurized fluidized bed combustion for power generation.** Moskowitz, S.; (Curtiss-Wright Corp., Wood-Ridge, NJ); Leon, A.; Mogul, J. Apr 1980.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

The plan for PFBC development was implemented in several ways. Initially, laboratory rigs were set up and tests were conducted to evaluate key areas under simulated conditions. While this provided a timely and cost effective approach for screening or parametric studies and where long term operation was not the objective, further data was necessary under conditions duplicating a coal-fired large or full scale PFB combustion system. Therefore, a large scale PFB technology rig was built using full scale bed internal hardware to provide full scale circulation and combustion patterns. Finally, a means of determining long term service operation on candidate materials of construction was necessary for selection of the alloys and/or coating systems that will withstand the commercially related exposure times. Permission was obtained from several commercial clients operating Dorr-Oliver designed fluidized bed reactors to install heat exchanger tubes in their units for extended exposure periods. The test data from this stepping stone approach toward PFBC development can be applied to utility demonstration units, industrial cogeneration systems, and a variety of FBC applications for energy intensive industries and ultimately can be used to exploit the commercialization potential of the PFB technology.

26826 (CONF-7906157—, pp 89-93) **Grimethorpe Research Programme.** Smith, D. (National Coal Board, Ltd., London, England). Apr 1980.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

The three countries agreed to three overall project objectives which are set out. The investigation of combustion, heat transfer, corrosion, gas clean-up, and energy recovery in a PFBC system can be considered as the major areas of technical interest. The performance factors in each area and their relationship with the overall project objectives are shown.

26827 (CONF-7906157—, pp 118-150) **Conceptual design and economic evaluation of various fluidized bed power plant concepts.** Huber, D.A.; Costello, R.M. (Burns and Roe Industrial Services Corp., Paramus, NJ). Apr 1980.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

Based on the prospective performance, economic, and environmental advantages of the PFB/AFB combined cycle power plant, further development of this promising concept should be energetically pursued. This study indicates that this system will be more economical than a conventional pulverized coal-fired plant and an AFB steam plant. The other five combined-cycle power plants examined gave less favorable results, although in some cases further study was recommended. (LTN)

26828 (CONF-7906157—, pp 151-169) **Progress on pressurized fluidized combustion at Leatherhead.** Hoy, H.R.; Roberts, A.G. (NCB Coal Utilization Research Lab., Leatherhead, England). Apr 1980.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

The main program of research on pressurized fluidized combustion at Leatherhead is to carry out 1000 hours of testing on the 2 1/2 MW (thermal) pilot-scale combustion with the objectives of assessing: (1) the performance of alloys which may be suitable for fabrication of tube banks; (2) corrosion/erosion/fouling of candidate gas turbine alloys; and (3) the performance of gas cleaning equipment, including comprehensive techniques for assessing the concentration of particulates in the combustion gases. The investigations form part of the US Department of Energy's program on the development of pressurized fluidized combustion for combined cycle power plant. The US Electric Power Research Institute (EPRI) is a major contributor and the Leatherhead program forms part of their investigations into the potentialities of PFBC for future power generating systems with particular emphasis on assessing the suitability of boiler tube materials. Other contributing or cooperating companies are mentioned briefly.

26829 (CONF-7906157—, pp 186-210) **Gas cleaning and emission control for pressurized combustion.** Johnson, I.; Jonke, A.A.; Swift, W.M.; Podolski, W.F. (Argonne National Lab., IL). Apr 1980.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

These studies at ANL support the national development program for pressurized fluidized-bed combustion. Laboratory and process development scale studies aimed at providing needed information on hot gas cleanup, limestone utilization improvement, emission measurement and control, limestone regeneration, and other tasks are underway. This paper summarizes some recent accomplishments and future plans.

26830 (DOE/ET/14851—2) **Development of combustion data to utilize low-Btu gases as industrial process fuels: modification of flame characteristics. Project 61041 quarterly report, 1 January-31 March 1980.** Waibel, R.T. (Institute of Gas Technology, Chicago, IL (USA)). Apr 1980. Contract AC01-79ET14851. 7p. NTIS, PC A02/MF A01.

This program consists of an experimental program to determine the burner modifications that will yield suitable flame characteristics and shapes with oxygen-blown gases manufactured from coal. Experiments will also be conducted to evaluate methods of enchancing the flame characteristics of manufactured gases from air-blown gasifiers. Progress to date includes a partial completion of the oxygen-enrichment system, preparation of the furnace for the trials, and discussions of the burner modifications needed for combustion trials with the burner manufacturer.

26831 (DOE/PETC/TR—80/5) **Recent coal-oil mixture combustion tests at PETC.** Pan, Y.S.; Bellas, G.T.; Mathur, M.P.; Joubert, J.I.; Bienstock, D. (Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Technology Center). Jun 1980. 38p. NTIS, PC A03/MF A01.

Coal-oil mixture combustion tests with coal concentrations of up to 50 percent were successfully conducted in a 700 horsepower watertube boiler designed originally for oil firing. A 500-h duration test with coal-oil mixture containing 40 percent coal has also been completed. No derating of the boiler occurred, carbon-conversion efficiencies were above 98 percent, and boiler efficiencies were the same as when firing No. 6 fuel oil. All combustion tests were conducted with No. 6 fuel oil mixed with Pittsburgh Seam coal pulverized to a coal particle size of 90 percent minus 200 mesh. Test results relating to boiler performance, pollutant emissions, ash deposition, and corrosion, erosion, and fouling behavior are presented.

26832 **Role of surface diffusion in the mechanism of surface reactions.** Yang, R.T.; Wong, C. (State Univ. of New York at Buffalo, Amherst). *J. Phys. Chem.;* 84: No. 6, 678-679(20 Mar 1980).

The Langmuir-Hinshelwood-Hougher-Watson mechanism was used to further investigate the mechanism of the C - O_2 reaction. Rates of oxidation by O_2 were measured for a disk of a single crystal of carbon and of particles of the same material using a Cahn recording microbalance. The samples were reacted under a flow velocity that was high enough to eliminate the effect of gas-film resistance on the overall rate; and as soon as oxygen flow was discontinued, argon flow was introduced to maintain the constant flow volume. At 850°C, the transient reaction rate was the same for the disc and the particle sample; but at 700°C, the rate deviated substantially after a certain time. The surface diffusion mechanism was found to be significant under conditions of lower temperature or partial pressure. Below the threshold pressure, surface diffusion became increasingly important; and, at still lower partial pressures, it was found to be pedominant in the overall reaction. Under the conditions where surface diffusion was found to be important, two rate processes were found to operate on the basal plane; chemisorption and surface diffusion with the relative magnitudes of the two rate processes being dependent only on the nature of the surface for the C - O_2 reaction system. (BLM)

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 26813

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 26799, 27885, 27972

26833 (LA—8363-PR) **Radioactive emissions from coal production and utilization. Work plan for 1 October 1979-30 September 1980.** Wagner, P.; Greiner, N.R. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 12p. NTIS, PC A02/MF A01.

The objectives of this program are to gather quantitative evidence to identify the nature and magnitude of potential health hazards due to radioactive emissions associated with the use of coal in electric power production and, if radioactivity of environmental concern is identified, to develop environmental controls to minimize those hazards. Three major tasks in this ongoing program are described. First, we will continue to measure, in the laboratory, the concentrations of uranium and thorium and their radiogenic daughters in typical coals, combustion products, wastes, and effluents associated with coal-based power production. We will continue to perform experiments to determine the extent of mobilization of these radionuclides by environmental forces such as weathering, leaching, and wind. If any unacceptable environmental hazards are identified we will perform the research necessary to develop environmental controls to mitigate these circumstances. The implication of our present data is that the partitioning factors between the different sectors of the coal utilization cycle depend on the chemistry of the different radionuclides, the chemistry and mineralogy of the coal, and the chemistry of the combustion process in the plant. Now that some of the general trends are being identified, more detailed experiments should be performed to generate a complete and definitive set of data on radionuclide partitioning in the different stages of a specific coal utilization scheme.

REGULATIONS

REFER ALSO TO CITATION(S) 26786

PETROLEUM

26834 (LBL—10270) **Expertise based energy information system.** Rosenberg, S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 12p. (CONF-800529—2). NTIS, PC A02/MF A01.

From American Society for Information Service mid-year meeting; Pittsburgh, PA, USA (15 May 1980).

An intelligent decision support system for energy information is described. The system draws on Artificial Intelligence technology, both in the design of the reasoning and representation components, and in the computer language. The computer language supports a powerful declarative semantics based on frame hierarchies. The design supports desirable user features such as substitution for incomplete data, data validation, caveat warnings, and simple noticing. A model of oil flow in the United States forms the semantic basis for the system. A reasoning component operating within this representa-

tion provides answers to queries; a capacity for analyzing energy scenarios; and complex monitoring of the database for developing trends.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 27996

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 28000

26835 (CONF-800650—1) **Some modern notions on oil and gas reservoir production regulation.** Lohrenz, J.; Monash, E.A. (Geological Survey, Denver, CO (USA). Conservation Div.). 21 May 1980. Contract AA01-75ET12169. 59p. NTIS, PC A04/MF A01.

From Symposium on oil and gas supply modeling; Washington, DC, USA (18 Jun 1980).

The historic rhetoric of oil and gas reservoir production regulations has been burdened with misconceptions. One was that most reservoirs are rate insensitive. Another was that a reservoir's decline is primarily a function of reservoir mechaism rather than a choice unconstrained by the laws of physics. Relieved of old notions like these, we introduce some modern notions, the most basic being that production regulation should have the purpose of obtaining the highest value from production per irreversible diminution of thermodynamically available energy. The laws of thermodynamics determine the available energy. What then is value. Value may include contributions other than production per se and purely monetary economic outcomes.

26836 (DOE/BETC/IC—79/5) **Equipment and procedures for fluid flow and wettability tests of geological materials.** Donaldson, E.C.; Kendall, R.F.; Pavelka, E.A.; Crocker, M.E. (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). May 1980. 43p. NTIS, PC A03/MF A01.

The Bartlesville Energy Technology Center, US Department of Energy, has developed several unique types of laboratory apparatus: (1) equipment for measurement of petroleum reservoir fluids at simulated subsurface conditions of temperature and pressure, (2) apparatus for saturation of geological cores with liquids, (3) design of a low internal volume pressure relief valve, and (4) apparatus and procedures for the quantitative determination of the relative wetting of oil and water on geologic materials. The fluid flow apparatus operates on the principles of liquid chromatography except for the replacement of the standard chromatographic column by a geologic core sample; it can be operated at an internal pore pressure of 400 atmospheres and 150°C. The apparatus can be applied to the measurement of the adsorption characteristics of reservoir fluids such as surfactants, polymers, chemical tracers and biocides; it is also applicable to the determination of relative permeability relationships and miscible and immiscible fluid flow behavior. The apparatus for the saturation of geologic cores is adaptable for simultaneous saturation of several small cores or a single core up to 50 cm in length and 4 cm in diameter. The pressure relief valve has an internal volume less than 0.5 ml and can operate at pressures as high as 500 atmospheres. The apparatus for determination of wettability was constructed by modification of a commercial centrifuge and the procedure is based on the thermodynamic work required for fluid displacement from a porous medium. This paper incorporates the design features and operational procedures of the apparatus in addition to the computer programs for calculation of miscible phase dispersion of reservoir fluids and adsorption characteristics of reservoir chemicals.

26837 (SAI—80-002-GLN) **Alternative concepts for supplying carbon dioxide for enhanced oil recovery projects.** Amirijafari, B.; Ford, H.; Grange, F.; Pforzheimer, T.; Williams, B. (Science Applications, Inc., Golden, CO (USA)). 14 Mar 1980. Contract EW-78-C-21-8333. 162p. NTIS, PC A08/MF A01.

The following objectives were accomplished: defining the CO_2 requirements for candidate enhanced oil recovery (EOR) reservoirs; generating alternative concepts for collecting, transporting, storing and processing CO_2 from naturally occurring sources and comparing them on the basis of cost effectiveness; and re-estimating the magnitude of the CO_2 EDR reserves based on the findings of this study. Fifty different natural gas purification processes for separating CO_2 were studied, and various modes of transportations and combinations were studied. If natural gases containing less than 10 mole percent CO_2 are processed, and trucks/trailers at 1000 psi and 90°F are used to transport it (a distance of 100 miles), the CO_2 can be made available at the point of consumption for about $1.5/MSCF. The above cost includes all of the purification cost for 100 MMSCFD of natural gas containing 7.5 mole % CO_2. Considering only the natural gases from the Western Overthrust Belt and the Tuscaloosa Trend, the CO_2 reserves could be increased about 14 trillion standard cubic feet. It is recommended that DOE include the following in their future programs: Experimental work determining vapor-liquid equilibrium ratios for mixtures of methane-carbon dioxide at temperatures and pressures encountered in processing the natural gas. Experimental work determining other physical properties, such as heat capacity, conductivity, compressibility, viscosity, etc. for CH_4 to CO_2 mixtures containing other impurities, such as H_2S or others which exist in natural gases in the United States. High pressure truck/trailers should be studied in greater detail to determine an optimum pressure considering practical construction materials plus transportation rules and regulations.

26838 **First joint SPE/DOE symposium on enhanced oil recovery.** Dallas, TX; Society of Petroleum Engineers (1980). 425p. (CONF-800411—).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Individual papers presented at this symposium were processed for inclusion in the Energy Data Base.

26839 **Multiple phase generation during CO_2 flooding.** Henry, R.L.; Metcalfe, R.S. pp 7-16 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Research to determine the pressure and temperature region in which multiple phases are generated for selected reservoir oils when displaced by CO_2 is described. The major purposes of this study were to (1) determine if single contact PVT data and multiple contact flow data generated multiple phases over equivalent pressures and temperatures, and (2) to determine if multiple phase generation would affect mobility. Multiple phases were generated for two reservoir oils of similar composition above the CO_2 minimum miscibility pressures for temperatures between 307.5 and 322 K. For a limited temperature range, the pressures over which these multiple phases were observed agreed fairly well with those determined in single contact PVT cell studies. However, multiple phases were also seen at higher temperatures in the multiple contact displacements. Pressure drop data as a function of CO_2 injection volume were obtained for displacements within the multiple phase region and for displacements conducted at pressures above the multiple phase region. Comparison of these data indicate that multiple phase generation reduces mobility within the flow system used. Mobility reduction would be beneficial during application of CO_2 flooding on a reservoir scale.

26840 **Phase behavior of CO_2 and cude oil in low temperature reservoirs.** Orr, F.M. Jr.; Yu, A.D.; Lien, C.L. pp 17-32 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Phase behavior of carbon dioxide-crude oil mixtures which exhibit liquid-liquid and liquid-liquid-vapor equilibria is examined. Results of single contact phase behavior experiments for CO_2 separator oil mixtures are reported. Experimental results are interpreted using pseudo-ternary phase diagrams based on a review of phase behavior data for binary and ternary mixtures of CO_2 with alkanes. Implications for the displacement process of liquid-liquid-vapor phase behavior are examined using a one-dimensional finite difference simulator. Results of the analysis suggest that liquid-liquid and liquid-liquid-vapor equilibria will occur for CO_2-crude oil mixtures at temperatures below about 50°C (122°F), and that development of miscibility occurs by extraction of hydrocarbons from the oil into a CO_2 rich liquid phase in such systems.

26841 **Effect of oil composition on miscible-type displacement by carbon dioxide.** Holm, L.W.; Josendal, V.A. pp 33-46 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Additional data related to the correlation between minimum miscibility pressure (MMP) for CO_2 flooding and the composition of the crude oil to be displaced are presented. Yelling and Metcalfe have stated that there is little or no effect of oil composition on the MMP. However, their conclusion was based upon experiments with one type of reservoir oil which was varied in C_1 to C_6 content and in the amount of C_7^+ present but which was not varied in composition of the C_7^+ fraction. We have found that the Holm-Josendal correlation, which is based upon temperature and C_5^+ molecular weight, predicts the general trend of the MMP's required for CO_2 flooding of various crude oils. MMP's were predicted with this correlation and then tested for several crude oils using oil recovery of 80% at CO_2 breakthrough and 94% ultimate recovery as the criteria. We now have data which show that miscible-type displacement is also correlatable with the amount of C_5 to C_{30} hydrocarbons present in the crude oil and with the solvency of the carbon dioxide as

indicated by its density. Variations from such a correlation are shown to be related to the C_5 to C_{12} content and to the type of these hydrocarbons. The MMP data were obtained from slim tube floods with crude oils having gravities between 28° and 44° API and molecular weights of C_5^+ between 171 and 267. The crude oils used varied in carbon residue between 1 and 4 wt % and in waxy hydrocarbon content between 1 and 17%. The required MMP for these crude oils at 165°F varied between 2450 and 4400 PSI for an oil recovery of 94% OIP. The MMP was found to be a straight line function of the amount of C_5 to C_{30} hydrocarbons present and of the density of the CO_2.

26842 Effect of nitrogen on the phase behavior and physical properties of reservoir fluids. Vogel, J.L.; Yarborough, L. pp 47-56 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Nitrogen can be produced from air separation plants at considerably less cost than the value of an equal volume of natural gas. For this reason, nitrogen has been considered for pressure maintenance operations in gas condensate and oil reservoirs. However, the possibility that significant changes in phase equilibria and physical properties could occur in the reservoir fluid has hindered its acceptance as an injection gas. Experimental laboratory tests were conducted in which gas condensate and black oil reservoir fluids were contacted by nitrogen at reservoir conditions. The results showed that the dew point pressures of gas condensates would significantly increase and retrograde liquid could condense where the nitrogen mixes with the reservoir gas. Additional contact by nitrogen revaporized a significant amount of the condensed retrograde liquid. The results also showed that the oil formation volume factor and solution gas-oil ratio decreased, and the oil density and viscosity increased when a black-type oil was contacted by nitrogen. The experimental tests were simulated using a modified Redlich-Kwong equation of state. The results showed that this equation of state can be tuned to reliably predict the effects of nitrogen on phase equilibria and physical properties of reservoir fluids. This equation of state could subsequently be used in compositional reservoir simulators to predict overall effects of nitrogen injection on reservoir performance.

26843 Field test of nitrogen WAG injectivity. Greenwalt, W.A.; Vela, S.; Christian, L.D.; Shirer, J.A. pp 57-66 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

A one well field test of nitrogen WAG (Water Alternating Gas) injectivity was conducted to determine if a reduction in water injectivity would occur after injection of nitrogen. A 40% reduction was observed immediately after nitrogen injection. Following three short WAG cycles, water injectivity increased to its pretest level with injection of a large volume of water.

26844 Use of the Peng-Robinson equation of state to predict hydrocarbon phase behavior and miscibilty for fluid displacement. Williams, C.A.; Zana, E.N.; Humphrys, G.E. pp 67-74 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Recent advances in computer implemented equations of state have made predictions of phase behavior easier and more reliable. They have also led to a different approach in predicting first contact and generated miscibility in hydrocarbon systems. In this study, the Peng-Robinson Equation of State is used to provide equilibrium gas and liquid compositions at reservoir temperature and hypothetical reservoir pressures. In predicting miscibility, a system's two-phase enevlope and associated tie lines are displayed as ternary diagrams. From these diagrams, a reservoir engineer can determine the minimum enrichment of intermediates (C_2-C_6) required for miscibility given reservoir pressure, reservoir fluid composition, and for a fixed reservoir temperature; or the minimum pressure for miscibility, given an injection gas and reservoir fluid composition. Experimental slim tube miscibility study results are compared to the method when available. We have successfully used this procedure to guide our laboratory reservoir evaluation programs, thereby saving experimental time and effort.

26845 Steam generation with high TDS feedwater. Elias, R. Jr.; Johnstone, J.R.; Krause, J.D.; Scanlan, J.C.; Young, W.W. pp 75-84 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Generating steam with an oilfield water containing a high concentration of total dissolved solids (TDS) was tested in the North Midway Field, Kern County, California. Conventional zeolite and weak acid cation exchange softeners were used for feedwater treatment, and steam was generated in a small scale oilfield boiler. Feedwaters with TDS concentrations up to 22,500 parts per million were successfully softened to zero hardness levels and converted to 70% quality steam at 2300 psig. Results show that it is not necessary to have relatively fresh water for use in conventional oilfield steam generators. Furthermore, water treatment costs are economic.

26846 Applicability of steamflooding for carbonate reservoirs. Nolan, J.B.; Ehrlich, R.; Crookston, R.B. pp 95-110 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Steamflooding can be a technically effective recovery method for carbonate reservoirs within certain parameter ranges. The attractiveness of steamflooding relates to the fact that heat conduction is a powerful mechanism for influencing the oil in the low permeability matrix in a heterogeneous formation, and the characteristically thick pay sections often associated with carbonate reservoirs result in relatively low heat losses to the confining strata. A numerical simulation model was used to study the effects of varying certain reservoir parameters (thickness, porosity, oil saturation, horizontal permeability, horizontal-to-vertical permeability ratio, well spacing and stratification) on performance parameters (steam-oil ratio, oil recovery and project life). Steam-oil ratios less than 5-1/2 and recoveries greater than 80% in the heated zones were predicted for certain ranges of these parameters that are realistic for some carbonate formations. Two methods of heat scavenging were investigated using numerical simulation and physical models. The more promising method was simply drawing down the reservoir pressure by continued production after stopping steam injection, thereby generating steam by water flashing in the heated zone. This reduced steamoil ratio by about 1-1/2 units in our test case, relative to continued steam injection, with only slightly reduced recovery and slightly increased project life.

26847 Check on numerical thermal simulation. Myhill, N.A. pp 111-117 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

A test of thermal numerical simulation is described. A three phase, three dimensional, numerical simulator duplicates reasonably well a complex laboratory steam drive. The laboratory steam drive was in a glass bead pack and was conducted at subatmospheric pressures. Since the matched steam drive was a laboratory one, much of the basic input data to the simulator was measured. The simulator used injection rate and reservoir pressure as input variables and calculated gross production, oil production, injection pressure and steam zone position as output variables. There is a closematch between the simulatory output and the experimental results.

26848 Salinity requirement diagram: a useful tool in chemical flooding research and development. Nelson, R.C. pp 131-142 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Optimal salinity, that level of brine salinity at which a chemical flooding surfactant displaces oil most efficiently, is related to midpoint salinity and to the range of salinity over which the phase environment is Type III. All three of these conditions are a function of surfactant concentration - usually decreasing as surfactant concentration decreases, particularly if the brine contains multivalent cations. A Salinity Requirement Diagram, constructed from phase equilibrium data, expresses quantitatively the dependency of midpoint salinity and the Type II range on surfactant concentration. Since surfactant concentration decreases as a flood with a small pore volume chemical slug proceeds, a Salinity Requirement Diagram can provide insight into the performance of chemical floods. Examples are presented which, among other things, support the proposal that chemical flooding is most efficient when conducted in a salinity gradient. A phenomenon in which a wedge of oil is left on the bottom of the core by a chemical flood is related to the Salinity Requirement Diagram for the system, and the effect of ion exchange on such diagrams is discussed.

26849 Evaluation of the salinity gradient concept in surfactant flooding. Hirasaki, G.J.; van Domselaar, H.R.; Nelson, R.C. pp 143-158 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

The goal of a salinity design strategy is to have as much of the surfactant as possible in the active region and to minimize surfactant retention. This task is complicated by the fact that (1) the compositions are changing as a result of dispersion, chromatographic separation of components distributed among two or more phases, and retention by adsorption onto the rock and/or absorption in a

trapped phase; (2) in the presence of divaent ions, the optimal salinity is not constant but is a function of the surfactant concentration and calcium/sodium ratio; and (3) the changing composition of the system has strong influence on the transport of the components. A one-dimensional, six component finite difference simulator has been used to evaluate the merits of a salinity gradient design in contrast to a constant salinity design. Numerical dispersion is used to evaluate the effects of dispersive mixing. It is shown that with a salinity gradient, the changing phase behavior with salinity can be used to advantage to keep the surfactant in the active region and to minimize surfactant retention. By contrast, it is shown that under some conditions, it is possible to have early surfactant break-through and/or large surfactant retention with a constant salinity design. Experimental observations show that high salinity does retard the surfactant and if the drive as high salinity, large surfactant retention can result. The design with the best recovery is one in which the waterflod brine is over-optimum and the drive is under-optimum. In such an experiment the peak produced surfactant concentration occurred in the active region and the oil production ceased at the same point.

26850 Effect of several polymers on the phase behavior of micellar fluids. Pope, G.A.; Tsaur, K.; Schechter, R.S.; Wang, B. pp 159-174 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Static measurement so the phase volumes of mixtures of surfactant, polymer, alcohol, water, n-octane, sodium chloride, and in some cases polymer additives were made. A limited number of viscosity, phase concentration, and interfacial tension measurements were also made. The purpose was to systematically determine the effect of various polymers on the phase behavior of various surfactant formulations. Measurements with and without oil (n-octane and n-octane/benzene mixtures) were made across a range of salinity appropriate to the particular surfactant at temperatures between 24 and 75°C. The polymers used were xanthan gum, hydrolyzed polyacrylamide, polyacrylamide, hydroxyethylcellulose, and polyethyleneoxide of three different molecular weights. The surfactants used were Exxon's C_{12} MEAOXS, Witco's TRS 10 to 80, Stepans Petrostesp 465, Alcolac's Siponate DS-10, GAF's Igepal CO-530 and CO-610, and Witco's ethoxylated alcohol TDA-100. The alcohols were isobutyl, secondary butyl, isopentanol, and isopropanol.

26851 Compositional effects on displacement mechanisms of the micellar fluid injected in the Sloss field test. Gupta, S.P. pp 175-188 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

The late performance of the micellar/polymer flood conducted in the Sloss reservoir has not followed predictions by a simple streamtube model. The model assumed classical miscible-immiscible displacements, sulfonate retention based on short-term laboratory adsorption tests and a final oil saturation to micellar flooding of 5% pore volume. This paper describes additional process mechanisms needed to model the flood performance and demonstrates that ion exchange, hardness, and sulfonate partitioning can significantly affect micellar flood performance. In particular, phase studies and sulfonate requirements must encompass effects of in situ generated calcium ions as a result of ion exchange. These effects can be experimentally determined by detailed mechanistic studies.

26852 Effect of dispersive mixing on scaling laboratory micellar floods. Gash, B.W.; Griffith, T.D. pp 189-198 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

For economic reasons, only a limited slug of a relatively expensive micellar fluid (followed by a polymer-water mobility bank) can be injected to displace oil with the current micellar flooding process. Once a micellar slug is injected, its composition does not remain the same; instead the compositions changes as the slug propagates. Scaling the micellar flooding process can be thought of as using laboratory tests which consider the compositional changes that occur as the slug propagates to determine the minimum size slug necessary for effective displacement of oil throughout the swept portion of the reservoir. Previous work has shown that surfactant retention is an important cause of compositional change which results in loss of displacement efficiency with a micellar slug. Dilution of a micellar slug (due to dispersive mixing) can be an equally important cause of poor displacement efficiency. In scaling a micellar flood, the dispersivity of the reservoir must be estimated from tracer tests. The ability of the micellar fluid to recover oil when it is diluted is a critical design criterion when reservoir dispersivity is large. Laboratory tests in short reservoir cores can be appropriate to simulate performance in a reservoir when the reservoir dispersivity is greater than the dispersivity of the reservoir cores. Berea sandstone which has very low dispersivity is not an appropriate porous medium in which to study the scaling of a micellar flood.

26853 Design and implementation of a Levelland Unit CO_2 tertiary pilot. Graham, B.D.; Bowen, J.F.; Duane, N.C.; Warden, G.D. pp 211-220 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Amoco Production Company installed a contained 1.5 acre (6 070m²) tertiary pilot project in the Levelland Field, Hockley County, Texas in 1978 in order to measure oil displacement that could be obtained by the carbon dioxide miscible recovery process in a completely waterflooded portion of the San Andres reservoir. The pilot was located in a previously waterflooded portion of the reservoir. Sizing of the pilot was based on available log and core data utilizing a channel flow reservoir simulator which was designed to simulate miscible flood behavior. Special steps were taken during the drilling of the pilot wells to insure controlled placement of the bottomhole locations. Extensive reservoir delineation testing took place prior to starting carbon dioxide injection. Significant information concerning carbon dioxide process feasibility is anticipated from this pilot. Steps taken to design, install, and operate the pilot are described.

26854 Review and analysis of past and ongoing carbon dioxide injection field tests. Goodrich, J.H. pp 221-234 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Under a contract with the US Department of Energy, Gruy Federal, Inc. has prepared comprehensive review reports for 19 projects in 16 fields in which carbon dioxide miscible injection was used to enhance oil recovery. Information from the geological and engineering literature, raw data from public records, and limited information supplied by project operators allowed nonproprietary reviw and analysis of 7 full-scale (i.e., commercial intent) field projects and 12 pilot projects. Abbreviated summaries of the field reviews for the full-scale projects are presented in this paper. Analysis and synthesis of the data and information from the field projects is also related to published CO_2 flooding technology. These data indicate that injection of CO_2 is a technically efficient enhanced oil recovery process over a wide range of geologic and reservoir conditions. Hence, published technical guidelines for judging applicability of CO_2 injection are probably too restrictive.

26855 Status of the Ten-Pattern Steamflood, Kern River Field, California. Oglesby, K.D.; Blevins, T.R.; Rogers, E.E.; Johnson, W.M. pp 235-242 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

The Ten-Pattern Steamflood was converted to water injection in September 1975, after 7 years of operation. Total recovery is now 62% of the original-oil-in-place, with 15% of this produced during the waterflood. Post-steam water injection apparently works best in reservoirs with large hot and unaffected zones remaining at the end of steam injection. ●

26856 Steamflood performance in the Kern River Field. Greaser, G.R.; Shore, R.A. pp 243-255 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

The Kern River Field is a large, shallow, heavy oil reservoir located five miles northeast of Bakersfield, California. Both reservoir and fluid characteristics are very favorable for thermal recovery methods. The unconsolidated oil sands exhibit high permeabilities of 1 to 5 darcies (1 to 5 μm^2) and porosities of 28 to 33%. Reservoir pressure is low, averaging 100 psig (690 kPa). Oil viscosities average 4000 cp (r Pa.s) at reservoir temperature and drastically reduce at elevated temperatures. Previous articles have been published concerning steamflood pilot design and behavior in the Kern River Field. This paper updates previous articles with a review of 263 steamflood patterns started in 1970 and 1971. The effects of sand thickness, completion interval and heat injection rates on steamflood recovery will be analyzed. Effective project evaluation through the use of temperature observation wells, coring, casing blow measurement and production from wells completed solely in the steamflood interval is emphasized. Problems of evaluating steamflood performance in a multi-zone reservoir are discussed and two field tests for improvement of steamflood sweep efficiency are also presented.

26857 Performance of South Swan Hills miscible flood. Griffith, J.D.; Cyca, L.G. pp 257-266 of First joint SPE/DOE symposium on

enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

A large scale miscible flood has been in operation in the South Swan Hills Unit (Beaver Hill Lake carbonate) since July 1973. Initial recovery estimates for the project were 45% by waterflood and 65% by miscible flood. Several approaches to evaluating the performance of the project have been applied including pressure coring, zonal testing, specialized logging and performance analysis. The pressure core analyses showed oil saturations significantly lower than residual water flood saturations and these data supported by other observations and analyses indicate a generally favorable performance of the project.

26858 Biopolymer injection into a low permeability reservoir. Carter, W.H.; Payton, J.T.; Pindell, R.G. pp 267-273 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Xanthan biopolymer has been shown to have effective mobility control properties in highly saline environments and to resist shear degradation. The use of this material in low permeability formations has been limited because of injectivity problems arising from the presence of cellular debris. The laboratory evaluation and field testing of an enzymatic clarification process, and subsequent polymer injection in a low permeability carbonate reservoir are presented. The studies show that increased solution viscosity and improved filterability can be achieved by prehydrating the polymer in fresh water, that the enzyme treatment can be effectively performed under field conditions, and that the process can lead to adequate polymer injectivity in a low permeability reservoir when good water quality and effective quality control procedures are maintained.

26859 Single well cyclic method for determining in situ chemical retention. Satter, A.; Shum, Y.M.; Widmyer, R.H. pp 275-288 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Reliable data on chemical retention in the reservoir is vital for designing chemical floods. A multiwell pilot can provide the needed information; however, such a project is expensive and time-consuming. Experience has shown that a chemical flood pilot can fall short of the predicted performance using the laboratory data and mathematial model studies. An alternative approach for obtaining retention under the reservoir condition is from a short duration, low cost field test using only a single well. The proposed technique entails multiple cycles of injection of a tertiary chemical solution containing a nonadsorbing tracer, soaking production from the same well. The concept initially was verified by tests conducted in laboratory core cells. A mathematical model also was developed for simulating the cyclic test. Finally, a field test was carried out in a well in the Manvel Field, Brazoria County, Texas, where a pilot chemical flood was underway. This paper presents the results of the aforementioned investigation. It is concluded that the single well cyclic test is a potentially vialble, short term, low cost technique for determining chemical retention in situ. The test may bridge the gap between the laboratory and pilot floods. Data obtained from such a test could yield scale-up criteria for designing and implementing a full scale pilot, or in determining the feasibility of even undertaking a project.

26860 Alternate slugs of gas and dilute surfactant for mobility control during chemical flooding. Lawson, J.B.; Reisberg, J. pp 289-304 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Studied was a novel technique for mobility control during chemical flooding, namely, the injection of alternate slugs of inert gas and surfactant solution. This method of reducing mobility offers a possible alternative to polymer thickened water. Performance was investigated in consolidated sandstone and carbonate. Sandstone included cores, and large slabs of rock oriented so as to maximize gravity segregation of gas. Reported data suggest that, for mobility control in laboratory rocks, performance of alternate slugs of gas and dilute surfactant compares favorably with water soluble polymers, without the many disadvantages of the latter. During experiments in large sandstone slabs, excessive foam drainage, and gravity segregation of gas, did not occur.

26861 Elementary mechanisms of oil recovery by chemical methods. Larson, R.G.; Davis, H.T.; Scriven, L.E. pp 305-321 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Basic mechanisms of oil recovery by introducing chemical agent act either by altering fractional flow relations, as by lowering interfacial tension or raising viscosity, or by changing phase behavior, as by making oil partially soluble in an aqueous phase (solubilization) or water soluble in the oleic phase (swelling). These mechanisms are catalogued. Simplified idealizations of them are analyzed with graphical constructions of Buckley-Leverett type for saturation and concentration profiles during representative linear displacements starting with waterflood residual. Emulsification mechanisms with non-equilibrium fluid states are shown to be amenable to similar analysis under certain conditions. Analysis of processes involving combinations of mechanisms as in practical chemical flooding is illustrated.

26862 Scaling of non-equilibrium phenomena in surfactant flooding. Hirasaki, G.J. pp 323-343 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Laboratory core floods are not conducted with the same time scale as field projects. Consequently, it is possible for non-equilibrium phenomena to be significant in laboratory core floods but be insignificant in field projects. The purpose of this paper is to analyze some non-equilibrium phenomena to determine scaling groups and qualitative behavior. Scaling groups were estimated for diffusion controlling and sorption rate controlling mass transfer. Further measurements are needed to quantify interfacial resistance controlling mass transfer and intraphase rate dependent phenomena.

26863 Effects of pore structure on displacement efficiency in reservoir rocks and in glass micromodels. Wardlaw, N.C. pp 345-352 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

In strongly wetted reservoir rocks, the extent of non-wetting phase trapping is strongly dependent on the geometric and topologic properties of the pore system. It has been demonstrated that porethroat size ratio and certain types of heterogeneity affect displacement efficiency adversely. Throat to pore coordination number or connectivity and the condition or roughness of pore surfaces are other important factors affecting displacement efficiency. Under conditions of intermediate wetting, pore geometry appears to be of reduced significance as a cause of trapping and, under these conditions, displacement efficiency is greater.

26864 Logging measurement of residual oil, Rangely Field, Colorado. Neuman, C.H. pp 353-362 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

This paper presents results of an effort to determine from well logs the oil remaining after waterflooding in the Rangely Field, Colorado. Four logging methods for measurement of residual saturations were attempted: resistivity, pulsed neutron capture, dielectric (electromagnetic propagation), and nuclear magnetism. Analyses of cores from the well were incorporated into log interpretation. The well was under-reamed after the mud salinity was increased and chemicals were added to the mud to cause the aqueous phase not to be detected by the Nuclear Magnetism Log (NML). The most accurate determination of residual oil was made from the NML run after the mud was treated. Reprocessing of the digitally-recorded NML data was necessary in order to achieve that accuracy. Saturations were calculated from the Electromagnetic Propagation Tool (EPT) using values for the dielectric properties of the rock matrix determined from a zone below the oil-water contact. Residual oil in place calculated from the EPT averaged essentially equal to that from the NML. Invasion of mud filtrate was not uniformly deep enough to enable accurate residual saturation determination by shallow-focusing resistivity or pulsed neutron capture logs. Because only the region very near the wellbore was uniformly invaded by mud filtrate, the NML and EPT were the only logging tools capable of measuring accurately the oil in place left after waterflooding.

26865 Role of clays in the enhanced recovery of petroleum. Somerton, W.H.; Radke, C.J. pp 363-380 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Many oil producing reservoir formations contain significant amounts of clays. Because of the large surface area involved and the high reactivity of such surfaces, the response of the formations to various recovery processes may be dominated by the reactions of the clays. The success or failure of enhanced recovery methods may be controlled to a large extent by the amount and type of clays in the formations to which the methods are being applied. The type and

amounts of clays and clay minerals present in typical oil producing formations, are being evaluated. After identification of the clay minerals present, tests are run on the extracted clay fractions to determine their cation exchange capacities, surface areas and chemical loss characteristics. Flood tests are run on extracted cores and then on native oil-bearing core samples to evaluate the magnitude of chemical loss and to note the change in flow characteristics as different fluids, are flowed through the core. This background material will be used to test predictive equations developed for screening reservoirs for enhanced recovery applications and for optimizing process variables. Techniques to counter the adverse effects of rockfluid interactions will be considered. The work accomplished to date on California sands is reported. Preliminary results and interpretation of a number of tests are presented.

26866 Rock structure and transport therein: unifying with Voroni models and percolation concepts. Pathak, P.; Winterfeld, P.H.; Davis, H.T.; Scriven, L.E. pp 381-395 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

Matrix and pores of rock form irregular, interpenetrating, network-like structures with interrelated shapes and connectivities that are statistical variables resulting from the nature of the original sediments and diagenetic processes they have suffered. Transport properties of either network depend on geometry, i.e. size and shape distributions; transport depends equally on the number of transport paths, or distribution of connectivity, i.e. topology. Thus different structural properties and transport processes in rock matrix and in pore space are interrelated. This theoretical prediction is studied by means of the Voronoi construction for subdividing space, which provides precisely defined, realistically irregular models of rock and of distributions therein of fluids, conductivity, permeability, strength, etc. Geometry and topology of the models are coded into matrices that are useful for thinking about structure and transport, and which become factors in illustrative calculations of electrical conductivity, Young's modulus, and fracture strength as functions of, for example, porosity. The results show percolation thresholds: cessation (or onset) of transport when a critical fraction of paths is randomly blocked (or created). Statistical features of structure and transport are the subject of percolation theory. The results help focus experimental studies and point to a unified picture of structure, strength, and transport.

26867 vhf electrical measurement of saturations in laboratory floods. Davis, L.A. Jr. pp 397-406 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

The changing oil/brine saturations along linear porous media during secondary and tertiary laboratory flood experiments have been measured using an electrical field detection technique. A short length of the cylindrically shaped medium is contained within the tank circuit capacitor of a very high frequency (vhf) oscillator operating above 100 MHz. The oscillator frequency is dependent upon the material's dielectric constant, which is a sensitive function of the oil/brine saturations. The oscillator and associated electronics comprise a small, self-contained unit free to slide along the core barrel. A coaxial cable connects this assembly to an external frequency counter. Frequency (saturation) measurements can thus be made at arbitrary flood times and points along the porous medium. The cylindrical symmetry of the flow cell is advantageous, since it maximizes the pressure containment capabilities of the necessarily nonmetallic core barrel materials. The design and performance characteristics of this core saturation monitor (CSM) are described, and its response related to oil saturation and brine conductivity. Examples include saturation scans of a sand pack undergoing oil saturation and water flood. The utility of the technique is demonstrated by contrasting the oil movement characteristics of three chemical floods.

26868 Alkaline injection for enhanced oil recovery: a status report. Mayer, E.H.; Berg, R.L.; Carmichael, J.D.; Weinbrandt, R.M. pp 407-418 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

In the past several years, renewed interest in enhanced oil recovery by alkaline injection has occurred. Alkaline solutions are also being used as preflushes in micellar-polymer projects. Several major field tests of alkaline flooding are planned, are in progress or have recently been completed. Considerable basic research on alkaline injection has recently occurred and is in progress. The paper summarizes known field tests and where available, summarizes the amount of alkali injected and the performance results. Recent laboratory work, much sponsored by DOE, and the findings are detailed. Alkaline flood field test plans for new projects are summarized.

26869 Petroleum sulfonates. Nussbaum, M.L.; Knaggs, E.A. (to Stepan Chemical Co.). US Patent 4,177,207. 4 Dec 1979. Filed date 3 Mar 1978. 36p.

Petroleum sulfonates yielding improved results in enhanced oil recovery processes are comprised of a reaction product obtained from a mixture of a major proportion of a petroleum oil feed stock, such as a crude or a portion thereof, and a minor proportion of an additive, such as an oxygenated hydrocarbon, i.e., an oxo-alcohol or the like, reacted with SO_3 under sulfonation conditions, mixed with about 0.5 to 20% (by reaction mixture weight) of water at the temperature in the range of about 50 to 150°C for a relatively brief period of time and then neutralizing the resultant material with a base, such as NaOH. The neutralized petroleum sulfonated material thus obtained, which may or may not be extracted to remove unsulfonated organic material or salts, is then formulated into a slug for injection into an oil field for enhanced oil recovery.

26870 How to determine residual oil saturation. Wesson, T.C. (Bartlesville Energy Technol Cent, Okla). *Pet. Eng.;* **51**: No. 15, 25-36(Dec 1979).

Accurate knowledge of oil saturation and its distribution is essential for any reservoir being considered for redevelopment or for secondary and tertiary operations. Determination of oil saturation forms the only rational basis for prediction of recoverable oil reserves. In addition, it is used for property evaluation for sale, bank loans, limits of investment for oil recovery, and it is critical in the selection, design, and economic evaluation of an oil-recovery process. Five techniques for determining residual oil saturation are reviewed: coring, logging, chemical tracer, reservoir engineering studies, and pressure transient tests. 1 ref.

26871 Sulfomethylated lignosulfonates as additives in oil recovery processes involving chemical recovery agents. Kalfoglou, G. (to Texaco Inc.). US Patent 4,172,498. 30 Oct 1979. Filed date 28 Apr 1978. 12p.

A process for producing petroleum from subterranean formations is disclosed wherein production from the formation is obtained by driving a fluid from an injection well to a production well. The process involves injecting via the injection well into the formation an aqueous solution of sulfomethylated lignosulfonate salt as a sacrificial agent to inhibit the deposition of surfactant and/or polymer on the reservoir matrix. The process may best be carried out by injecting the sulfomethylated lignosulfonates into the formation through the injection well mixed with either a polymer, a surfactant solution and/or a micellar dispersion. This mixture would then be followed by a drive fluid such as water to push the chemicals to the production well.

26872 (DOE/BC/20009—6) Tertiary recovery of Pennsylvania grade crude oil with surfactant solutions. Quarterly Report for the Period January-March 1980. (Pennsylvania State Univ., University Park (USA)). [nd]. Contract AS19-78BC20009. 15p. NTIS, PC A02/MF A01.

The projects include surfactant synthesis, surfactant solution development, porous media viscometry, surfactant adsorption studies, flow rate and sweep efficiency studies, buffer solution development, low-permeability sandstone flood tests, and produced water disposal.

PROCESSING

26873 Conversion of carbon monoxide. Chester, A.W. (to Mobil Oil Corp.). US Patent 4,181,600. 1 Jan 1980. Filed date 25 Jul 1978. 12p.

A metal combustion promoter is introduced to the circulating inventory of catalyst in a catalytic cracking unit as a mixture of particles rich in metal with particles free of metal such that the net concentration of metal in the mixture is about 1 to 10 ppM. According to a preferred embodiment the particles rich in metal contain about 50 ppM of platinum, iridium, osmium, palladium, rhodium, ruthenium or rhenium. When such mixtures are supplied to the circulating inventory, it is found that specific activity of the metal is enhanced in the sense that activity of the mixture for oxidation of carbon monoxide is higher than that of catalyst in which an equal amount of metal is evenly distributed among all the particles.

26874 Process for the hydrotreating of heavy hydrocarbon streams. Quick, L.M.; Hensley, A.L. Jr. (to Standard Oil Co. (Indiana)). US Patent 4,181,602. 1 Jan 1980. Filed date 7 Dec 1978. 20p.

The molybdenum is present in an amount within the range of about 5 to 15 wt %, calculated as MoO_3 and based on the total catalyst weight; the chromium, within the range of about 5 to 20 wt %, calculated as Cr_2O_3 and based on total catalyst weight; and the cobalt, within the range of about 0.1 to 5 wt %, calculated as CoO and based on the total catalyst weight. The process comprises contacting a heavy hydrocarbon stream under suitable conditions and in the presence of hydrogen with a catalyst comprising a

hydrogenating component selected from the group consisting of (1) molybdenum, chromium, and a small amount of cobalt, (2) their oxides, (3) their sulfides, and (4) mixtures thereof deposed on a large-pore, catalytically active alumina. The molybdenum is present in an amount within the range of about 5 to 15 wt %, calculated as MoO_3 and based on the total catalyst weight; the chromium, within the range of about 5 to 20 wt %, calculated as Cr_2O_3 and based on total catalyst weight; and the cobalt, within the range of about 0.1 to 5 wt %, calculated as CoO and based on the total catalyst weight. The catalyst possesses a pore volume within the range of about 0.4 cc/gm to about 0.8 cc/gm, a surface area within the range of about 150 m^2/gm to about 300 m^2/gm, and an average pore diameter within the range of about 100 A to about 200 A.

26875 Feed hydrotreating for improved thermal cracking. Sze, M.C. (to Lummus Co.). US Patent 4,181,601. 1 Jan 1980. Filed date 7 Apr 1978. 6p.

A process is described for hydrogenation of a thermal cracking feedstock in the presence of a bimetallic catalyst containing added chlorine and/or fluorine prior to noncatalytic thermal cracking. The preferred catalysts are tungsten - nickel sulfide, cobalt - molybdenumm sulfide, nickel - molybdenum sulfide, or tungsten - cobalt sulfide supported on silica, alumina, zeolites, or activated alumina containing ZrO_2 or TiO_2 with added chlorine and/or fluorine. The process results in increased yields of light olefins and BTX (benzene, toluene, and xylene) as compared to cracking under conditions of pre-hydrogenation in the presence of an unpromoted bimetallic catalyst. (BLM)

26876 Process for utilizing petroleum residuum. McConaghy, J.R. Jr. (to Conoco, Inc.). US Patent 4,176,046. 27 Nov 1979. Filed date 26 Oct 1978. 4p.

A petroleum refinery vacuum residuum stream is subjected to hydrogen donor diluent cracking, and the liquid cracking effluent is hydrodesulfurized. The hydrodesulfurizer effluent is then fractionated, and the fractionator bottoms stream is fed to a delayed coker where premium type delayed coke is produced. The gas oil boiling range fraction from the fractionator is utilized as the donor diluent in the cracking step.

26877 Phyrolysis coke inhibition. Leftin, H.P.; Newsome, D.S. (to Pullman Inc.). US Patent 4,176,045. 27 Nov 1979. Filed date 10 Jul 1978. 10p.

In the production of lower olefins by steam cracking normally liquid hydrocarbons at very short residence times, the formation of coke deposits in cracking furnace tubes is minimized by the addition of a low-coking hydrocarbon to fresh feed having a high coking tendency.

26878 Process for conversion of heavy hydrocarbons. Corns, J.B.; Nevitt, T.D.; Hertwig, W.R. (to Standard Oil Co. (Indiana)). US Patent 4,176,048. 27 Nov 1979. Filed date 31 Oct 1978. 8p.

Heavy hydrocarbon streams containing asphaltenes are hydrocracked in a first hydrocracking zone, and asphaltenes are removed from the liquid effluent to form a deasphaltened liquid feed to a second hydrocracking zone. The deasphaltened liquid can then be more severely hydrocracked to a high conversion level without the plugging problem caused by asphaltene deposition.

26879 Catalytic cracking process. Winter, W.E.; Schuette, W.L. (to Exxon Research and Engineering Co.). US Patent 4,176,049. 27 Nov 1979. Filed date 3 Apr 1978. 10p.

A process is described which comprises recracking a cracked naphtha feed containing up to about 60%, suitably from about 20 to about 40% olefins, over a crystalline aluminosilicate zeolite catalyst to further crack the naphtha and saturate at least about 50% of the olefins, preferably from about 90 to about 100% of the olefins, based on the weight of the cracked naphtha feed. In a preferred combination a gas oil is catalytically cracked in a first stage to produce a cat cracked naphtha product of high olefin content, and an intermediate boiling component thereof is recracked as a feed in a second stage over a zeolite catalyst to saturate the olefins, and hydrodenitrogenate and hydrodesulfurize the cat cracked naphtha. The recracked cat cracked naphtha is then hydrotreated at low to mild severities and then catalytically reformed (hydroformed) to produce high octane gasoline.

26880 Process for alkylating waxy hydrocarbons with C_3-C_5 carbon atom secondary alcohols as catalyst. White, A.M. (to Exxon Research and Engineering Co.). US Patent 4,176,044. 27 Nov 1979. Filed date 22 May 1978. 6p.

Waxy, normally solid hydrocarbons are alkylated to form liquid hydrocarbons boiling in the lube oil range by contacting the wax and a low molecular weight olefin, such as ethylene, with a catalyst comprising a C_3-C_5 carbon atom secondary alcohol at elevated temperature and pressure. This process is useful for making relatively high viscority index(VI) lube oils from wax, for decreasing the pour point of jet fuels and for dewaxing lube oil feedstocks.

26881 Dehydrogenation process and catalyst. Ellis, M.C.; Manning, H.E. (to Petro-Tex Chemical Corp.). US Patent 4,172,854. 30 Oct 1979. Filed date 9 Jan 1975. 14p.

A process for dehydrogenation of gaseous hydrocarbons and the catalyst employed for the process are described. The cyclic process consists of dehydrogenation of the hydrocarbons such as butane, isopentane, or ethylbenzene over the catalyst to produce butenes and butadiene, isopentene and isoprene, and styrene, respectively. The process alternates cycles of dehydrogenation and catalyst regeneration during which coke is burned off the catalyst by passing molecular oxygen through the catalyst. The dehydrogenation catalyst in magnesium chromite having the formula $MgCr_2O_4$ and containing from 2 to 8% of Li based on the $MgCr_2O_4$ (BLM)

26882 Process and apparatus for ethylene production. Pavilon, S.J. (to Arthur G. McKee and Co.). US Patent 4,172,857. 30 Oct 1979. Filed date 3 Apr 1978. 16p.

A thermal cracking process and apparatus are disclosed for economical manufacture of lower olefins and valuable coproducts by pyrolysis of liquid or gaseous hydrocarbon feedstocks ranging from ethane to tar sands particularly feedstocks, such as gas oil, naphtha, residual oils or tar sands. The pyrolysis unit is a riser reactor heated by hot agglomerated ash particles and designed for short residence time to minimize the time of contact of the feedstock with the hot ash. The agglomerated ash is continually produced in a fluidized bed combustion unit by burning particles of coal or other solid carbonaceous material, and the hot agglomerated ash is continually forced upwardly through the riser by superheated steam which is further superheated in the riser reactor and which serves as dilution steam for hydrocarbon partial pressure reduction. Additional dilution steam enters the reactor with the preheated feedstock. A water quench at the outlet of the reactor slows down or stops secondary reactions as the cracked gases are separated from the hot ash in a roughing cyclone separator. The ash particles, which are coated with coke or char after reaction, are preferably steam stripped to remove occluded hydrocarbon and are thereafter recycled to the bed of the combustion unit. If the feedstock is tar sand or a feedstock with high coking tendencies, it may be preferable to burn at least part of the char or coke coated ash and/or sand particles from the riser reactor in a separate burner and thus dispose of some of the solids before the ash recycle to the main combustion unit.

26883 Simultaneous production of jet fuel and diesel fuel. Jacobs, W.L. (to UOP Inc.). US Patent 4,172,815. 30 Oct 1979. Filed date 21 Sep 1978. 6p.

A hydrocracking process for the simultaneous production of jet and diesel fuel is a two-step process. The charge stock having a boiling point greater than 500°F and contaiing a substantial portion of cyclic hydrocarbons is reacted with H_2 in a catalytic reaction zone, and the reaction zone products are then separated into the two desired boiling range streams. At least a portion of the jet fuel boiling range stream is recirculated to the catalyst reaction zone. The catalyst used in the reaction zone is made up of 2 wt % Ni and 14 wt % Mo combined with an alumina or silica carrier. (BLM)

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 26883

26884 (EMD—80-39) Emergency allocation rules fail to recognize needs of petrochemical industry. Staats, E.B. (General Accounting Office, Washington, DC (USA)). 21 May 1980. 52p. General Accounting Office, Washington, DC.

Report to The Congress by the Comptroller General of the United States.

The petrochemical industry uses petroleum and natural gas for making its products as well as meeting its fuel needs. However, current Government allocation programs pertain solely to fuel uses, not to the industry's material feedstock requirements. Failure to recognize the feedstock requirements could result in supply constrictions with a disproportionate impact on the industry. At this time, it is difficult to assess the feedstock requirements of the petrochemical industry because the Government lacks a definition of the industry itself, and what data it has is insufficient to provide a basis for an effective allocation program. GAO recommends a number of actions to overcome these Department of Energy deficiencies.

26885 Manufacture of lube base stock oil. Gillespie, B.M.; Sarli, M.S.; Smith, K.W. (to Mobil Oil Corp.). US Patent 4,181,598. 1 Jan 1980. Filed date 20 Dec 1977. 12p.

Lube base stock oil of low pour point and excellent stability is produced from a waxy crude oil fraction by solvent refining, catalytic dewaxing over a zeolite catalyst in the nature of zeolite ZSM-5 and hydrotreating under specified conditions.

26886 **Production of high V.I. lubricating oil stock.** Chen, N.Y.; Garwood, W.E.; Peters, A.W. (to Mobil Oil Corp.). US Patent 4,176,050. 27 Nov 1979. Filed date 4 Dec 1978. 10p.

Waxy distillate lubricating oil stocks suitable for the preparation, by conventional unit processes, of high viscosity index (V.I.), low pour point lubricating oils, are advantageously catalytically dewaxed with macrocrystalline ZSM-5 zeolite catalyst (crystallites larger than 2 microns) preferably associated with a hydrogenation metal such as platinum or palladium.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 27954

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 27277, 27278

26887 (DOE/EIA/AR—0221) **Filling the strategic petroleum reserve: its price and economic effects.** Paul, E.S. (Department of Energy, Washington, DC (USA). Energy Information Administration). Mar 1980. 52p. NTIS, PC A04/MF A01.

The estimated movements of the economic indicators under the 1989 target plan (with no OPEC retaliation) are small and could be considered almost negligible when viewed against the size of the economy and the error properties inherent in the macroeconomic model. Therefore, it cannot be firmly stated that a significant loss in real output and increases in inflation and unemployment occur in filling the Reserve. Accelerating the fill rate to meet the 1985 Target (without OPEC retaliation) could increase world oil prices from $0.90 to $1.00 above the base case of no Reserve buildup for the year 1980 to 1985. For the same period, this results in an estimated average decrease in real output of 0.6 percent per year below the baseline level for the United States, an increase in the inflation rate by an average of 0.3 percentage points per year, and an increase in the unemployment rate by an average of 0.2 percentage points per year above their baseline values. In the OPEC retaliation scenario, the world oil price is projected to rise immediately by 19.6 percent above its baseline level, and, by 1985, to be 6.1 percent above the baseline level for the 1989 Target, and 8.4 percent for the 1985 Target. The average loss in real output in the United States could be 0.8 percent below the baseline value for the year 1980 to 1985 for 1985 and 1989 Targets. The GNP deflator could be greater by an average of 0.8 percentage points, and the unemployment rate greater by an average of 0.5 percentage points per year when compared with their baseline values.

26888 (EMD—80-47) **Some issues affecting Southern California Outer Continental Shelf oil and gas lease Sale 48.** Staats, E.B. (General Accounting Office, Washington, DC (USA)). 5 May 1980. 66p. General Accounting Office, Washington, DC.

This report discusses the value and effect of the Interior Department's Outer Continental Shelf Environmental Studies Program on decisions leading up to leasing 148 Outer Continental Shelf tracts in Southern California. It also discusses the usefulness of resource reports submitted by various Federal agencies in defining the sale area. GAO's review indicated that neither the Environmental Studies Program nor the resource reports had a major impact on Sale 48 decisions. Industry high bids for the sale tracts were 20 times greater than Interior value estimates, again creating concern as to Interior's ability to evaluate Outer Continental Shelf lands. An alternate bidding system - bonus bid with a sliding scale royalty - was used for half the tracts offered in Sale 48 to increase competition and small company participation in the sale. The bidding results indicate that the sliding scale alternative did not provide the hoped for results.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 26890, 27680, 27684, 27912, 27913, 27935, 27941, 28002

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 26884, 27279, 27280

26889 (DOE/RG—0029) **Standby Gasoline Rationing Plan.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). Jun 1980. 127p. NTIS, PC A07/MF A01.

The final rules adopted by the President for a Standby Gasoline Rationing Plan are presented. The plan provides that eligibility for ration allotments will be determined primarily on the basis of motor vehicle registrations, taking into account historical differences in the use of gasoline among states. The regulations also provide authority for supplemental allotments to firms so that their allotment will equal a specified percentage of gasoline use during a base period. Priority classifications, i.e., agriculture, defense, etc., are established to assure adequate gasoline supplies for designated essential services. Ration rights must be provided by end-users to their suppliers for each gallon sold. DOE will regulate the distribution of gasoline at the wholesale level according to the transfer by suppliers of redeemed ration rights and the gasoline allocation regulations. Ration rights are transferable. A ration banking system is created to facilitate transfers of ration rights. Each state will be provided with a reserve of ration rights to provide for hardship needs and to alleviate inequities. (DC)

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 27277, 27278

26890 **Performance of oil industry cross-country pipelines in Western Europe. Statistical summary of reported spillages: 1978.** de Waal, A.; Baradat, Y. Den Haag; Concawe (1979). 14p. (CONCAWE—6/79).

CONCAWE's annual report on oil industry cross-country pipelines in Western Europe shows that in 1978 the pipeline network reached a combined length of 18,500 kilometres and transported 594 million cubic metres of crude oil and refined products. The gross spillage amounted to 3639 m^3, that is 0.000613 percent or about 6.1 parts per million of the total quantity transported. The net spillage loss was 1,377 m^3 since 2,262 m^3 were recovered at site. There were 15 spillage incidents reported during 1978, all of which were directly related to pipelines (none to pump-stations). In 4 incidents the oil spilled was completely recovered, and in 10 cases clean-up was completed within one week of the discovery of the spillage. No contamination of potable water sources was reported. The causes of the spillages are attributed to corrosion (7 incidents), third party activities (4), mechanical failure (3) and natural hazards, i.e. excessive rainfall (1). The report also gives a comparison for the five-year period 1974 to 1978.

PROPERTIES

REFER ALSO TO CITATION(S) 26808

26891 (DOE/BETC/PPS—80/2) **Aviation turbine fuels, 1979.** Shelton, E.M. (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). May 1980. 15p. NTIS, PC A02/MF A01.

Properties of some aviation turbine fuels marketed in the United States during 1979 are presented in this report. The samples represented are typical 1979 production and were analyzed in the laboratories of 17 manufacturers of aviation turbine (jet) fuels. The data were submitted for study, calculation, and compilation under a cooperative agreement between the Department of Energy (DOE), Bartlesville Energy Technology Center (BETC), Bartlesville, Oklahoma, and the American Petroleum Institute (API). Results for the properties of 93 samples of aviation turbine fuels are included in the report for military grades JP-4 and JP-5, and commercial type Jet A.

STORAGE

26892 (UCRL—52829) **Improving the performance of brine wells at Gulf Coast strategic petroleum reserve sites.** Owen, L.B.; Quong, R. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Nov 1979. Contract W-7405-ENG-48. 545p. NTIS, PC A23/MF A01.

At the request of the Department of Energy, field techniques were developed to evaluate and improve the injection of brine into wells at Strategic Petroleum Reserve (SPR) sites. These wells are necessary for the disposal of saturated brine removed from salt domes where oil is being stored. The wells, which were accepting brine at 50 percent or less of their initial design rates, were impaired by saturated brine containing particulates that deposited on the sand face and in the geologic formation next to the wellbore. Corrosion of the brine-disposal pipelines and injection wells contributed to the impairment by adding significant amounts of particulates in the form of corrosion products. When tests were implemented at the SPR sites, it was found that the poor quality of injected brines was the primary cause of impaired injection; that granular-media filtration, when used with chemical pretreatment, is an effective method for removing particulates from hypersaline brine; that satisfactory injec-

tion-well performance can be attained with prefiltered brines; and that corrosion rates can be substantially reduced by oxygen-scavenging.

COMBUSTION

REFER ALSO TO CITATION(S) 26831

NATURAL GAS

REFER ALSO TO CITATION(S) 27266

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 26910

26893 (BMFT-FBT—79-31) **Direct detection of hydrocarbons using seismic procedures.** Millahn, K.O.; Koitka, H.; Jurczyk, D.; Jankowsky, W.S. (Prakla-Seismos G.m.b.H., Hannover (Germany, F.R.)). May 1978. 161p. (In German). NTIS (US Sales Only), PC A08/MF A01.

Methods for determination of amplitudes and spectra of seismic signals were combined to form a reliable and versatile interpretational system which allows an economical, semiautomatic extraction and a spatial presentation of various seismic parameters for lithological studies. An application of the system to an offshore survey area shows clear correlation between high amplitude anomalies and gas zones. Other indicators of hydrocarbons do not show such significant anomalies. Any quantitive interpretation of the results is impeded by complex layering of sandbeds which cannot be resolved by seismic techniques. The reliable lithological interpretation has to be tested by further experimental application to seismic data and has to be supported by petrophysical studies. A method was developed which allows a reliable determination of frequency-dependent attenuation if clear signals, undistorted by interference, are available and if comparatively high minimal attenuation is present. Problems which occur in the application to seismic data are discussed.

26894 (DOE/BC/00010—17) **Porosity determination from neutron, density, and sonic logs in western gas sands. Annual report, 1 October 1978-30 September 1979.** Osoba, J.S.; Carroll, H.B. Jr. (Texas A and M Univ., College Station (USA); Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). Jun 1980. Contract AC19-78BC00010. 30p. NTIS, PC A03/MF A01.

The porosities of core samples from the Natural Buttes 21 in Uinta County, Utah, have been measured in the laboratory using three techniques. Two techniques involve a helium porosimeter, and the third requires that the sample be saturated with kerosene and the difference between the saturated and the dry weight used as an indication of the porosity. The best method for determining porosity in the laboratory has not been selected. Initial results of determining porosities of intervals from the Natural Buttes 21 well using wireline logs indicate that the porosities calculated from the density logs might be too low if standard procedures are used. Matrix densities needed to calculate the correct porosities using the density logs were higher than normally used in the tight western gas sands. The error in calculating the porosity from the density log could underestimate the volume of gas-in-place in the tight western gas sands.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 26835, 26882

26895 **Technology and economics of methane production from geopressured aquifers.** Doscher, T.M.; Osborne, R.H.; Wilson, T.; Rhee, S.; Cox, D.; Kuuskraa, V. (Univ of South Calif, Los Angeles). *J. Pet. Technol.*; **31**: No. 12, 1502-1514(Dec 1979).

The purpose of this study was to estimate the cost of producing methane (natural gas) from geopressured aquifers inland from and along the coast of the Gulf of Mexico. No other economic values of the geopressured brines were considered for exploitation. The study leads to the conlusion that profitable exploitation of such reservoirs is not likely to occur in the near future, mainly because of the great reservoir size required to sustain economic production rates and the cost of disposing of spent brines. 32 refs.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 26907

26896 **Sixth international conference on liquefied natural gas. Volume 1. Sessions I and II.** Chicago, IL; Institute of Gas Technology (1980). vp. (In French and English). (CONF-800445—(Vol.I)). $60.00 (Vols. 1 and 2).

From 6. international conference and exhibition on liquefied natural gas; Kyoto, Japan (7 Apr 1980).

Developments in the LNG industry were discussed at this conference. Separate abstracts are prepared for individual items. Topics covered include: LNG and world energy supplies and developments in LNG technology. A separate abstract was prepared for each of 21 papers for the Energy Data Base (EDB), 16 of which are included in ENergy Abstracts for Policy Analysis (EAPA). (DC)

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 26888, 26896, 26904, 26907

26897 (OTA-E—110) **Alternative energy futures. Part 1. The future of liquefied natural gas imports.** (Office of Technology Assessment (U.S. Congress), Washington, DC). Mar 1980. 126p. GPO.

This assessment responds to a request by the Senate Committee on Finance for an evaluation of the economic and energy implications of any future liquefied natural gas (LNG) imports. This part of Office of Technology Assessment (OTA's) continuing examination of Alternative Energy Futures complements and expands upon an earlier OTA report, Transportation of Liquefied Natural Gas. Highlights of the study include a discussion of worldwide availability of natural gas for U.S. import as LNG, in the context of projected U.S. gas demand, alternative North American oil and gas resources, and the security of foreign supplies. The report also contains sections on LNG project structure, cost, and financing with observations about balance-of-payment impacts and public exposure to financial risk. Finally, an analysis of the behavior of gas markets in determining who receives additional supplies of virtue of LNG projects, and who pays for them, illustrates some of the practical efforts of the Natural Gas Policy Act of 1978.

26898 **Natural gas industry reports record customers served on slightly less volume.** Arlington, VA; American Gas Association (1977). 4p.

In the year-end statement of the A.G.A., it is stated that 45.3 million customers were served by the natural gas utility industry during 1977. Residential customers are up, but residential use declined by 2.1% over 1976. Gas utility sales revenues was $27.8 billion in 1977. A breakdown is given of the sales and revenues for residential, commercial, industrial, and other customers; percentage change over 1976 is also given. (DLC)

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 28000

26899 (DOE/BC/10003—7) **Western Gas Sands Project. Status report, 1 March-31 March 1980.** (CER Corp., Las Vegas, NV (USA)). 1980. Contract AC08-78BC10003. 59p. NTIS, PC A04/MF A01.

The March, 1980 progress of the government-sponsored projects directed towards increasing gas production from the low permeability gas sands of the western United States is summarized in this report. A site for the multi-well experiment was approved by the industry review committee; drilling is expected by mid-summer. Bartlesville Energy Technology Center continued work on fracture conductivity, rock/fluid interaction, and log evaluation and interpretation techniques. Lawrence Livermore Laboratory continued experimental and theoretical work on hydraulic fracturing mechanics and analysis of well test data. Analysis of data obtained from a test of the borehole seismic unit by Sandia Laboratories continued. The DOE Well Test Facility continued bottom-hole pressure buildup measurements at the Colorado Interstate Gas Company Miller No. 1 well.

26900 (DOE/BETC/RI—80/2) **Stochastic model of MHF propagation.** Palmer, I.D.; Carroll, H.B. Jr. (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). Jun 1980. 10p. NTIS, PC A02/MF A01.

A Monte Carlo model of the propagation of a hydraulic fracture through an inhomogeneous medium was constructed for use in the Western Gas Sands Project. The region through which the two-dimensional fracture propagates has a random variation of mini-

mum in situ stress imposed upon it. By dividing the fracture into a number of sectors, the stress-intensity factor of each sector tip is calculated and compared with the fracture toughness at that point. The model produces an irregular fracture profile and fluctuations in the bottomhole fluid pressure. The irregularity in the profile is quite marked for the case of a stress distribution with mean 5000 psi and standard deviation 100 psi imposed randomly on a grid of resolution 40 feet. Many Monte Carlo trials will lead to a statistical probability of achieving a certain fracture radius (or wing length) and provide a relation between magnitude of pressure fluctuations and variations of minimum in situ stress.

26901 (DOE/METC/SP—2) **Unconventional gas recovery program. Semi-annual report for the period ending September 30, 1979.** Manilla, R.D. (ed.). (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). Apr 1980. 477p. NTIS, PC A21/MF A01.

This document is the third semi-annual report describing the technical progress of the US DOE projects directed at gas recovery from unconventional sources. Currently the program includes Methane Recovery from Coalbeds Project, Eastern Gas Shales Project, Western Gas Sands Project, and Geopressured Aquifers Project.

26902 (SAND—79-2428) **Enhanced gas recovery program. Fourth annual report, October 1978-September 1979.** Northrop, D.A.; Schuster, C.L. (eds.). (Sandia Labs., Albuquerque, NM (USA)). Nov 1979. Contract AC04-76DP00789. 121p. NTIS, PC A06/MF A01.

Massive hydraulic fracture diagnostic experiments continued in FY 79 with the major activity being focused on the development of wireline tool instrumentation. Nevada Test Site substantiate field data obtained in two experiments with Amoco in their Wattenberg field. A high-resolution, three-dimensional seismic survey program was initiated. The program will start with some experiments at shallow depths where the sand lenses outcrop and then move into greater depths to evaluate this technique. A logging program was also established to evaluate formation properties. Hydraulic and dynamic fracturing experiments were conducted adjacent to a tunnel complex at the Nevada Test Site and which are then directly observed by mining through the experiment area. Evaluation of fracturing tests at an interface between geologic formations with significantly different properties showed that the interface did not contain the fractures. A microcrack model has been formulated which downplays the importance of material properties and emphasizes the role of in-situ stresses for processes occurring at a crack tip. Multiple fracturing from a wellbore has been demonstrated for a High Energy Gas Frac concept. Finally, a Multi-Well Experiment has been defined whose objectives are to characterize in detail a lenticular gas reservoir of the Western United States and to evaluate state-of-the-art and developing technology for the recovery of gas from them.

26903 (UCRL—52908) **Review of the mechanics and occurrence of natural fractures in rock as applied to the development of the tight western gas sands.** Towse, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 May 1980. Contract W-7405-ENG-48. 34p. NTIS, PC A03/MF A01.

The tight gas sands in the Rocky Mountains are thin, discontinuous, and have low permeability. They are found in gently folded rocks and often have abnormally high pore pressure. In a relaxed tectonic setting, one principal stress is most often nearly vertical and the other two horizontal. Natural fractures usually approximate the same orientation to stresses as those produced experimentally. Increased pore pressure extends the depth to which extensional fractures can occur; these tend to form perpendicular to the direction of the least principal stress. Local stresses that control small features such as joints may be different from, although compatible with, regional stress. In folded rocks, sliding and bending forces appear to be most important in forming the smaller structures, such as joints. Fractures can be formed by flexing during downwarp and uplift; more intense folding or faulting is not necessary. Fractures are controlled by the physical environment, the stresses, and the nature of the rock. Changes in stress due to burial and uplift are also important. Jointing frequency is greater in weak and thinly bedded rocks and is directly related to intensity of folding. Two sets of both shear and extensional fractures may develop: one oriented parallel, the other normal, to axes of folding or downwarp. These relations may be used to extrapolate fracture patterns laterally or into the subsurface.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 26907

26904 (DOE/RG—0026/1) **Regulatory analysis for review and establishment of natural gas curtailment priorities. Volume 1.** (Department of Energy, Washington, DC (USA). Office of Regulations and Emergency Planning). May 1980. 120p. NTIS, PC A06/MF A01.

This report discusses important differences among alternatives for establishing natural gas curtailment priorities to deal with long-run supply shortages and short-run capacity shortages. Results from surveys and simulation of shortage costs for each alternative curtailment plan produced and major findings that are directly relevant for considering possible changes in the present curtailment system are discussed. This volume should be used to identify basic alternatives, to review findings which can guide review of any proposed policy change, and to gain a basic understanding of how curtailment alternatives were evaluated. This volume is sufficient for gaining an overall understanding of the effect that natural gas curtailment can have on both users and suppliers.

26905 (DOE/RG—0026/2) **Regulatory analysis for review and establishment of natural gas curtailment priorities. Volume 2.** (Faucett (Jack) Associates, Inc., Chevy Chase, MD (USA)). May 1980. Contract AC01-78RG03355. 171p. NTIS, PC A08/MF A01.

The overall perspective for policy review is in Volume 1. It contains a concise statement of the problem, a list of policy alternatives, all study findings, and an outline of the evaluations which produced the study findings. Volume 2 is a detailed evaluation of each policy alternative, except for the environmental impact assessment in Volume 3. Both Volumes 2 and 3 are designed to add details for the reader who has already studied Volume 1; background in Volume 1 is not repeated in other volumes. Volume 2 should be used to understand the basic causes for the differences in curtailment alternatives presented in Volume 1. It should also be used to gain understanding of how any additional curtailment alternative must be evaluated before it can be safely implemented. This volume also discusses the following basic policy goals which should guide the selection of any policy change: (1) efficiency as measured by shortage costs and supplier costs, (2) equity as measured by fairness among groups, (3) administrative burden as measured by record keeping and implementation problems, and (4) contribution toward special goals such as oil import reduction.

26906 (DOE/RG—0026/4) **Regulatory analysis for review and establishment of natural gas curtailment priorities.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). May 1980. Contract AC01-78RG03355. 234p. NTIS, PC A11/MF A01.

Technical appendices in Volume 4 provide data and detailed explanations for each of the seven components into which policy evaluation has been divided: (1) delineation of alternatives and then simulation of shortage. under each alternative in each prototype company, (2) supplier decisions and costs, including allocation rules, (3) user fuel substitution costs, (4) calculation of user shortage costs, supplier operating cost, and non-user pollution cost, (5) institutional factors affecting implementation, (6) annual demand and supply trends, and (7) national projections for economic and environmental summaries. In essence, there is increasing detail and more intricate discussion from Volume 1 to Volumes 2 and 3 and then to the Technical Appendices in Volume 4. Volume 4 should be used to gain understanding of the many different curtailment plans across the nation and to better appreciate the types and levels of costs that occur to both users and suppliers. The diagrams and discussions in Volume 4 will help the reader interpret the important concepts in designing and evaluating curtailment alternatives. The scenarios on demand and supply in Volume 4 can provide background for other studies.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 27053, 27281

26907 **Sixth international conference on liquefied natural gas. Volume 2. Sessions III and IV.** Chicago, IL; Institute of Gas Technology (1980). vp. (In English and French). (CONF-800445—(Vol.2)). $60.00 (Vols. 1 and 2).

From 6. international conference and exhibition on liquefied natural gas; Kyoto, Japan (7 Apr 1980).

LNG transport and handling were discussed in session III of this conference. A session IV contains papers discussing the legal and financial aspects of LNG trade. An appendix is included which contains papers on various aspects of liquefaction of natural gas. A separate abstract was prepared for each of the individual items, nineteen of which are included in Energy Abstracts for Policy Analysis (EAPA). (DC)

PROPERTIES

REFER ALSO TO CITATION(S) 26908

COMBUSTION

26908 **Vapor cloud explosion study.** Panarouskis, M.C. (Coast Guard, Washington, DC); Lind, C.D.; Raj, P.P.K.; Cece, J.M. pp 16p, Session III, Paper 12 of Sixth international conference on liquefied natural gas. Volume 2. Sessions III and IV. Chicago, IL; Institute of Gas Technology (1980).

From 6. international conference and exhibition on liquefied natural gas; Kyoto, Japan (7 Apr 1980).

In the late 60's, it became evident that LNG would be imported into the United States in large quantities, thus necessitating the need for new marine facilities. The US Coast Guard, which would be involved in the approval of these new facilities, began the Vapor Cloud Explosion Study in 1973 in order to gain a better understanding of the properties of LNG, particularly when released into the environment. The study was divided into five phases: Phase I included an analytical evaluation of the possible magnitude and damage potential of a spill of LNG; Phase II consisted of shock tube tests and tests in thin film hemispheres to evaluate potential transition from deflagration to detonation in unconfined clouds of flammable gases; Phase III included a series of spills of LNG onto water to determine pool size, flame height, flame radiation, vapor dispersion, and flame speed through a vapor cloud; Phase IV consisted of a series of spills of LPG and gasoline onto water to provide direct comparison of the hazard potential of LNG, LPG, and gasoline; Phase V consisted of additional thin film hemisphere tests to determine whether a detonation initiated by a high explosive charge or a detonation exiting a tube could be sustained within an unconfined vapor cloud. Preliminary analysis of the data indicate that (1) transition from deflagration to detonation in unconfined vapor clouds does not appear to occur; (2) flame heights observed during LNG pool fires are taller than predicted; (3) LNG pool fires do not spread over the entire pool surface; (4) LNG is extremely difficult to detonate; (5) due to higher flame speeds, fires on LPG pools tend to cover the entire pool surface; and (6) the emissive power of the flame in both LNG vapor and pool fires is higher than expected.

STORAGE

REFER ALSO TO CITATION(S) 26896

OIL SHALES AND TAR SANDS

26909 (CONF-800205—11) **Alumina from oil shale.** Smith, J.W. (Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center). 1980. 9p. NTIS, PC A02/MF A01.

From American Institute of Metallurgical Engineers meeting; Las Vegas, NV, USA (Feb 1980).

Dawsonite-bearing oil shale of Colorado's Green River Formation offers a unique and vast (6.5 billion tons of Al_2O_3) resource of easily extractable alumina. The processing methods required by the thermal reactions of dawsonite and its oil-shale carrier also require production of shale oil, soda ash, and nahcolite as marketable coproducts. These production methods are presented. The alumina production process is contrasted with the Bayer process to describe technical advantages of extraction of alumina from oil shale which may offset the problems associated with processing a relatively lean ore. While alumina production from oil shale requires development of new technology, the technical problems appear solvable. Only the political problems arising from the now onerous and completely unnecessary Federal oil-shale withdrawal appear less solvable.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 26941, 26942, 26943

SITE GEOLOGY AND HYDROLOGY

SITE GEOLOGY

26910 (MLM-MU—80-65-0008) **Physical and chemical characterization of Devonian gas shale. Quarterly status report, January 1-March 31, 1980.** Zielinski, R.E.; Nance, S.W. (Mound Facility, Miamisburg, OH (USA)). 1980. Contract AC04-76DP00053. 161p. (MLM-EGSP-TPR-Q—013). NTIS, PC A08/MF A01.

A change in the format of the Mound Facility EGSP reports begins with this issue. The geochemical characterization data is reported by well instead of by the type of analysis. For most well sections stratigraphic intervals are identified. The stratigraphic zones were picked from borehole logs. The logs and sample datums are discussed in the text. No concentrated effort was made to develop a rigid system of formation and member names. The well logs were generally tied to the nearest available USGS or state generated cross-sections, therefore, the interval names should only be used as a guide for determining stratigraphic position. The general location of wells and corresponding well data used by Mound Facility in its EGSP study is indicated in tables and figures.

DRILLING, FRACTURING, AND MINING

26911 (SAND—80-1203C) **True in-situ bed preparation: oil shale and tar sand.** Boade, R.R. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 25p. (CONF-800541—2). NTIS, PC A02/MF A01.

From Tar sands permeability enhancement workshop; Albuquerque, NM, USA (8 May 1980).

In 1978, a detailed study was conducted to evaluate the status of the bed preparation technology that had been developed for true in-situ processing of oil shale. It was concluded that the two techniques which had received the bulk of the attention in prior field experimentation, namely the wellbore springing and hydraulic/explosive fracturing concepts, both had inherent traits which would prevent them from being useful in practical applications. In the current paper, the previous results are reviewed to determine whether or not they are also applicable to tar sand. The conclusion reached is that neither technique would be practical for preparing a tar sands deposit for in-situ processing.

OIL PRODUCTION, RECOVERY, AND REFINING

REFER ALSO TO CITATION(S) 26811

26912 **Monitoring in situ retorting processes of oil shale by reflected and transmitted electromagnetic waves.** Hong, S.H.; DuBow, J.B. (Department of Electrical Engineering, Colorado State University, Fort Collins, Colorado 80523). *J. Appl. Phys.;* **51**: No. 7, 3953-3956(Jul 1980).

A theoretical model for an in situ oil shale retort with three distinct vertical zones, all surrounded by a wall of oil shale, overburden and underburden, is considered for the study of potential electromagnetic monitoring of the progression of retorting processes using wave propagation techniques. The overall power reflection and transmission coefficients for both transverse electric and transverse magnetic waves are used for finding the position of a combustion zone in the retort, based upon the assumption of straight-line propagation of monochromatic plane waves through layered lossy dielectric media characterized by the dielectric constants and loss tangents. The behavior of each power coefficient is discussed as a function of burn front positions and signal frequencies. As a result of the relatively moderate signal power for each coefficient required for detection, and the one-to-one correspondence between each power coefficient and burn front position at typical conditions, the feasibility of using low radio-frequency waves to monitor relatively large scale in situ retorting process is established.

IN SITU METHODS, TRUE AND MODIFIED

26913 (DOE/LETC/EA—0104) **Environmental assessment: tar sand in situ steam injection experiment.** (Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center). Dec 1979. 49p. NTIS, PC A03/MF A01.

A field experiment is planned for the in situ recovery of bitumen from tar sand. The site is located on a ten acre site 6.5 miles West of Vernal, Utah, and the experiment will last about six months. The experiment will utilize steam to lower the viscosity of the bitumen and drive it into production wells where it is recovered. Due to the small scale of this experiment, the impact of the proposed action will be minimal. Impact on local biological life will be minimal. The experiment will have no effect on aquatic habitats. No rare or endangered biological species will be affected by the experiment.

26914 (DOE/LETC/RI—80/4) **True in situ oil shale retorting experiment at Rock Springs site 12.** Long, A. Jr.; Merriam, N.W.; Virgona, J.E.; Parrish, R.L. (Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center). May 1980. 31p. NTIS, PC A03/MF A01.

A true in situ oil shale fracturing and retorting experiment was conducted near Rock Springs, Wyoming in 1977, 1978, and 1979. A 20-foot (6.1 m) thick zone of oil shale located 200 feet (61 m) below surface was hydraulically and explosively fractured. The fractured oil shale was extensively evaluated using flow tests, TV logging, caliper logging, downhole flow logging, core samples, and tracer tests. Attempts to conduct true in situ retorting tests in

portions of the pattern with less than 5 percent void space as measured by caliper logs and less than 1 percent active void space measured by tracer test were curtailed when air could not be injected at desired rates. It is thought the fractures plugged as a result of thermal swelling of the oil shale. Air was injected at programmed rates in an area with 10 percent void measured by caliper log and 1.4 pecent active void measured by tracer test. A burn front was propagated in a narrow path moving away from the location of the production well. The vertical sweep of the burn front was measured at less than 4 feet (1.3 m). The burn front could not be sustained beyond 10 days without use of supplemental fuel. The authors recommend a minimum of 5 percent well-distributed void for attempts to retort 20 gpt (81 L/m ton) oil shale in confined beds. A void space of 5 percent may be roughly equivalent to 5 to 10 percent measured by caliper log and 1.4 percent or more by tracer test.

26915 (UCID—16986-80-1) **Oil shale project. Quarterly report, January-March 1980.** Rothman, A.J. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1980. Contract W-7405-ENG-48. 45p. NTIS, PC A03/MF A01.

Results are reported on pilot retorting operations including: simulated modified in-situ (MIS) operations, aging of crushed shale, temperature measurement methods, intermittent retorting and recycled offgas. Field testing of retort operation and control is discussed. Model calculations of Rio Blanco No. 0 and No. 10 are summarized. The effects of using oxygen diluted by steam or carbon dioxide in MIS retorting are reported. (DC)

26916 (UCID—18708) **Effect of oil-shale grade on carbonate-decomposition rates in an autogenous atmosphere.** Burnham, A.K.; Koskinas, G.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1980. Contract W-7405-ENG-48. 20p. NTIS, PC A02/MF A01.

The rate of CO and CO_2 evolution from Colorado oil shale heated at a constant rate under an autogenous atmosphere is reported. Three samples with grades of 84, 150 and 251 l/Mg were investigated. The gas evolution rates from powdered samples in an autogenous atmosphere are nearly identical with those from solid cores. The rate of dolomite decomposition depends strongly on the grade of the oil shale and the presence of a sweep gas. Results are tentatively interpreted in terms of the accessibility of the dolomite crystals to steam produced during retorting.

26917 **Hydrocarbon-steam processes for recovery of bitumen from oil sands.** Redford, D.A.; McKay, A.S. pp 119-130 of First joint SPE/DOE symposium on enhanced oil recovery. Dallas, TX; Society of Petroleum Engineers (1980).

From SPE/DOE symposium on enhanced oil recovery; Tulsa, OK, USA (20 Apr 1980).

The use of hydrocarbons together with steam was investigated as a means for improving recovery and other operating parameters in the interwell vertical steam-stimulation process for recovery of bitumen from oil sands. A total of 42 experiments were conducted using a two-well, 18-in-diam., three-dimensional elemental physical simulator operating at conditions close to those anticipated in the oil sands area of interest. The results of 20 of these experiments are presented. A range of hydrocarbons from methane through ethane, propane, butane, pentane, natural gasoline, naphtha, to synthetic GCOS crude were investigated. The results of many of these experiments are presented and a number of observations and conclusions drawn. A proposed recovery process based on this work is presented.

SURFACE METHODS

26918 (UCRL—83788) **Retorting and combustion processes in surface oil-shale retorts.** Lewis, A.E.; Braun, R.L. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). 2 May 1980. Contract W-7405-ENG-48. 10p. (CONF-800806—12). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

Lawrence Livermore's mathematical model for a batch oil-shale retorting process has proved useful in understanding in situ retorting in a bed of oil-shale rubble. This model is based on an improved understanding of the physical and chemical processes involved in retorting. It has since been modified to calculate the retorting of shale moving through a retort, as required for a continuous process in surface equipment. Calculations were made in which the retorting process that releases oil from raw shale is physically separated from the combustion process that recovers energy from spent shale by burning the residual carbon. Calculations were also made with the retorting and combustion processes combined in one unit. Results of the calculations illustrate the advantages and disadvantages of inert-gas and combustion retorts. Temperature control and the efficient use of energy from the nonliquid products of pyrolysis are key problems in surface retorting processes. The amount of gas produced by the combustion of char with air is insufficient to retort shale without steep temperature gradients which, in turn, may make the temperature difficult to control and result in the loss of oil yield. 13 figures, 3 tables.

26919 **Apparatus and system for processing oil shale.** Hanson, L. US Patent 4,180,718. 25 Dec 1979. Filed date 31 Oct 1977. 6p.

Apparatus is described for treating oil shale by microwave energy for recovering heated volatile fractions thereof. The microwave oven includes a sloping feeder made of glass, pyrex, or ceramic material. The feeder is reciprocated back and forth along a declining plane so as to advance slowly but progressively oil shale deposited on the top end thereof to the discharge end of the vibrator. Means are provided to evacuate volatile fractions and to feed such gases through preheater tubes to a condenser unit. The preheater tubes are disposed in line with and through the flow of incoming materials so as to tend to regulate material descent as well as preheat the shale. An additional solids heat exchanger is employed underneath the discharge end of the vibratory feeder means so as to slow the descent of the spent shale onto its ultimate conveyor as well as taking heat therefrom and from magnetron tubes of the oven to conduct such heat upwardly to further increase the preheating effect upon incoming shale. Condenser units are employed and a prime mover-generator unit are used to utilize a portion of the recovery for ultimately powering such magnetron tubes to produce the electromagnetic wave energy necessary to heat the shale and vaporize its bituminous constituents.

26920 **Process for thermal cracking a heavy hydrocarbon.** Taciuk, W. (to Alberta Oil Sands Technology and Research Authority). US Patent 4,180,455. 25 Dec 1979. Filed date 23 Dec 1977. 30p.

There is provided an apparatus comprising rotating inner and outer concentric tubes. The inner tube provides a vapor zone and the annular space between the tubes provides a combustion zone. Hot particulate solids, such as sand, are advanced along an endless path through the vapor zone, back through the combustion zone and back into the vapor zone. In the vapor zone, oil is sprayed on the hot solids. The mixture is mixed and cascaded to obtain heat transfer from the solids to the oil, thereby generating hydrocarbon vapors and coke deposition on the solids. The vapors are removed by suction from the vapor zone. The coked solids are transferred into the combustion zone and cascaded and lifted and dropped therein to mix with added oxygen. Coke is burned to heat the solids which are then returned to the vapor zone. The vapors generated in the combustion zone are removed by suction. Segregation of the atmospheres in the two zones is achieved by a combination of maintaining equal pressures in the zones and using the solids, being transferred from one zone to the other, to block gas flow.

REFINING

REFER ALSO TO CITATION(S) 26874, 26878, 26882, 27441, 27442

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 26916, 27441, 27562

26921 (CONF-800575—1) **New method to determine the independent shear moduli of transversely isotropic materials.** Chong, K.P.; Chen, J.L.; Uenishi, K.; Smith, J.W. (Wyoming Univ., Laramie (USA); Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center). 1980. Contract AT20-80LC10224. 15p. NTIS, PC A02/MF A01.

From 4. SESA international congress on experimental mechanics; Boston, MA, USA (25 May 1980).

A new and simple method is presented to determine the independent shear moduli of transversely isotropic materials. The method is tested on Green River Formation oil shale, one of such materials. The method is applicable for linear and nonlinear elastic materials. Mathematical formulation, derivation and solution are given, and test apparatus and results are presented. Comparison with other approximate results and acoustical methods are made. Confirmation of the test method with materials having known shear moduli is also presented.

26922 (FE—2346-66) **Pyrochromatographic study of Michigan antrim shale.** Snyder, R.H.; Maness, M. (Core Labs., Inc., Mt. Pleasant, MI (USA)). May 1980. Contract AC20-76LC10153. 75p. NTIS, PC A04/MF A01.

Pyrochromatographic analyses were performed on samples of Antrim shale from 35 wells and nine outcrops in the Michigan Basin. Hydrocarbon components from C_6 to C_{30} were measured. The majority of the analyses indicate the Antrim to be potentially gas productive. The total hydrocarbon count for each well was divided by the number of samples analyzed to obtain the average hydrocarbon count per sample. Hydrocarbon counts per sample generally

increase with depth and toward the center of the Michigan Basin. A bar graph for each well, showing the total hydrocarbon count for each sample, by depth, was plotted and compared with the gamma ray log. A correlation coefficient of 0.696 between increased hydrocarbon counts and increased radioactivity was calcuated based on data from five wells.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 27885, 27954

WASTE RESEARCH AND MANAGEMENT

26923 (LBL—10481) **Anaerobic biological treatment of in-situ retort water.** Ossio, E.; Fox, P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 51p. NTIS, PC A04/MF A01.

Anaerobic fermentation was successfully used in a laboratory-scale batch digester to remove soluble organics from retort water. Required pretreatment includes reduction of ammonia levels to 360 mg-N/l, pH adjustment to 7.0, sulfide control, and the addition of the nutrients, calcium, magnesium, and phoshorus. If the prescribed pretreatment is used, BOD_5 and COD removal efficiencies of 89 to 90% and 65 to 70% are achieved, respectively.

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 26811, 26913, 27935, 27941

NUCLEAR FUELS

RESERVES

REFER ALSO TO CITATION(S) 26936

26924 (GJBX—126(80)) **Regional and local anomalies of uranium and thorium in rocks near sandstone-type uranium deposits in Pennsylvania and Colorado.** Rose, A.W.; Pirc, S.; Tole, M.P.; Bell, C.A.; Keith, M.L.; Pilione, L.J. (Pennsylvania State Univ., University Park (USA)). May 1980. Contract AC13-76GJ01664. 211p. NTIS, PC A10/MF A01.

The geochemistry of U and Th in about 500 shales and sandstones from the Catskill Formation in Pennsylvania and the Morrison and adjoining formations in the Uravan mineral belt of Colorado has been investigated to evaluate the magnitude and extent of regional detrital U and Th anomalies, and more local anomalies in the paleoaquifers through which U was transported to form the deposits. Background U and Th are negatively related to grain size and positively related to Al, Ti, and other components of the fine fraction. Weak anomalies in U and Th are accentuated by examination of residuals (deviations) from regressions of U or Th against Al, or U against Th. Some anomalies are accentuated by analysis of extractable U rather than total U. In the Catskill Formation near Jim Thorpe, Pa., the Duncannon-Clarks Ferry Member, which hosts roll-type U ores near Penn Haven Junction, is enriched in both U and Th by 20 to 50%, compared to the underlying Long Run Member which lacks U occurrences; it is also enriched compared to laterally equivalent Duncannon-Clarks Ferry samples 20 to 120 km to the southwest. Zircons from the sandstones show a similar pattern. A U-rich source area apparently was exposed and supplying detritus to the Jim Thorpe area in Duncannon-Clarks Ferry time. The oxidized paleoaquifer through which U reached the roll-type U occurrences contains a fourfold enrichment of U, apparently by adsorption of U from the ground water which formed the rolls. In Colorado, no regional depositional trends, either lateral or vertical, were found in the U and Th content of the host Salt Wash Member, but the entire Morrison Formation may be slightly enriched in U and Th relative to underlying units. The Salt Wash sediments near Uravan contain about twice background amounts of U.

26925 (K/CSD—13) **Methods for obtaining distributions of uranium occurrence from estimates of geologic features.** Ford, C.E.; McLaren, R.A. (Oak Ridge National Lab., TN (USA)). Apr 1980. Contract W-7405-ENG-26. 121p. NTIS, PC $9.15/MF $3.50.

The problem addressed in this report is the determination of a quantitative estimate of a resource from estimates of fundamental variables which describe the resource. Due to uncertainty about the estimates, these basic variables are stochastic. The evaluation of random equations involving these variables is the core of the analysis process. The basic variables are originally described in terms of a low and a high percentile (the 5th and 95th, for example) and a central value (the mode, mean or median). The variable thus described is then generally assumed to be represented by a three-parameter lognormal distribution. Expressions involving these variables are evaluated by computing the first four central moments of the random functions (which are usually products and sums of variables). Stochastic independence is discussed. From the final set of moments a Pearson distribution is obtained; the high values of skewness and kurtosis resulting from uranium data requires obtaining Pearson curves beyond those described in published tables. A cubic spline solution to the Pearson differential equation accomplishes this task. A sample problem is used to illustrate the application of the process; sensitivity to the estimated values of the basic variables is discussed. Appendices contain details of the methods and descriptions of computer programs.

EXPLORATION

REFER ALSO TO CITATION(S) 26910, 27537

26926 (GJBX—74(80)(Vol.1)) **Airborne gamma-ray spectrometer and magnetometer survey, Unalakleet quadrangle (Alaska). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Feb 1980. Contract EY-76-C-13-1664. 103p. NTIS, PC $10.50/MF $3.50.

During July, August, and September of 1979, an airborne high sensitivity gamma-ray spectrometer and magnetometer survey was conducted over ten 3^0 x 1^0 NTMS quadrangles of West-Central Alaska. The results obtained over the Unalakleet map area are discussed. The final data are presented in four different forms: on magnetic tape; on microfiche; in graphic form as profiles and histograms; and in map form as anomaly maps and flight path maps.

26927 (GJBX—80(80)(Vol.2)) **Airborne gamma-ray spectrometer and magnetometer survey, Iditarod quandrangle (Alaska). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Mar 1980. Contract AC13-76GJ01664. 114p. NTIS, PC A06/MF A01.

The histograms and the multiparameter profiles are presented with the anomaly maps and flight path map.

26928 (GJBX—87(80)) **Engineering report on the drilling in the Lemhi Pass area of Montana.** Abramiuk, I.N. (Bendix Field Engineering Corp Grand Junction, CO (USA)). May 1980. Contract AC13-76GJ01664. 17p. NTIS, PC $5.30/MF $3.50.

Engineering details, statistics, individual borehole histories, and geophysical logs of the four holes drilled in the Lemhi Pass, Montana/Idaho, area are presented. The purpose of the Lemhi Pass drilling project was to obtain subsurface and geophysical information in support of the US Geological Survey - US Department of Energy (USGS-DOE) thorium resource assessment project. The four holes cored ranged in depth from 484 to 711 feet (147.52 to 216.71 m) for a total of 2378 feet (724.81 m).

26929 (GJBX—94(80)(Vol.1)) **Airborne gamma-ray spectrometer and magnetometer survey: Kantishna River quadrangle (Alaska). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Apr 1980. Contract AC13-76GJ01664. 106p. NTIS, PC $10.50/MF $3.50.

During July, August, and September of 1979 an airborne high sensitivity gamma-ray spectrometer and magnetometer survey was conducted over ten 3^0 x 1^0 NTMS quadrangles of west-central Alaska. The results obtained over the Kantishna River map area are discussed. The final data are presented in four forms: on magnetic tape; on microfiche; in graphic form as profiles and histograms; and in map form as anomaly maps, flight path maps, and computer printer maps. Thirteen appendices are included.

26930 (GJBX—94(80)(Vol.2)) **Airborne gamma-ray spectrometer and magnetometer survey, Kantishna River quadrangle (Alaska). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Apr 1980. Contract AC13-76GJ01564. 116p. NTIS, PC A06/MF A01.

The histograms, the multiparameter profiles, anomaly maps, and flight path map are presented.

26931 (GJBX—98(80)) **Geologic report on East Chaco Canyon drilling project, McKinley and San Juan Counties, New Mexico.** Lease, L.W. (Bendix Field Engineering Corp., Grand Junction, CO (USA)). May 1980. Contract AC13-76GJ01664. 61p. NTIS, PC A04/MF A01.

The East Chaco Canyon drilling project of northwestern New Mexico was comprised of 15 holes drilled to an average depth of 4695 feet (1431 m). These holes were drilled to obtain data on extensions of the uranium producing strata of the Grants mineral belt into a deeper unexplored portion of the San Juan Basin. The goal of the project was to obtain subsurface data that would reduce the uncertainty of resource estimates of the Morrison Formation within

the project area and other deeper portions of the basin. Preliminary geologic and land status studies were initiated in June 1977. Drilling began in July 1978 and was completed during November 1978. A total of 70,421 feet (21,464.3 m) was drilled of which 4938 feet (1505 m) was cored. The cored intervals included virtually all the Westwater Canyon Member and portions of the Brushy Basin and Recapture Members of the Morrison Formation. A suite of lithologic and geophysical logs was obtained from each drill hole. A comprehensive study of the Westwater Canyon Member core from each drill hole is being made by the Department of Geology of the University of New Mexico. Zones of minor uranium mineralization were encountered in both the Westwater Canyon and Brushy Basin Members of the Morrison Formation. The zones commonly occurred at the contacts between beds of altered, originally arkosic, coarse-grained, poorly sorted sandstones and finer grained sedimentary units. The best developed zone of mineralization (8 feet [2.4 m] of 0.125% eU_3O_8) occurred within a sandstone of this type that was separated from the underlying Westwater Canyon Member sandstones by about 27 feet (8.2 m) of typical Brushy Basin Member claystone.

26932 (GJBX—102(80)) **Engineering report on drilling in the San Rafael Swell area, Utah.** Jones, L.I. (Bendix Field Engineering Corp., Grand Junction, CO (USA)). May 1980. Contract AC13-76GJ01664. 93p. NTIS, PC $10.50/MF $3.95.

The San Rafael Swell drilling project was conducted by Bendix Field Engineering Corporation in support of the US Department of Energy National Uranium Resource Evaluation (NURE) program. This project consisted of 27 drill holes ranging in depth from 120.0 ft (36.5 m) to 3,700.0 ft (1,127.7 m). A total of 41,716 ft (12,715 m) was drilled, of which 3,099.8 ft (944.8 m) were cored. Geophysical logging was supplied by Century Geophysical Corporation and Bendix Field Engineering Corporation. The objective of the project was to test the uranium potential of the Triassic and Jurassic sandstone units and to investigate areas where industry was unlikely to drill in the near future. Drilling commenced September 24, 1978, and was finished on December 17, 1979.

26933 (GJBX—115(80)) **Hydrogeochemical and Stream Sediment Reconnaissance basic data for Iron River NTMS Quadrangle, Michigan/Wisconsin.** (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 30 Apr 1980. Contract AC13-76GJ01664. 255p. (K/UR—137). NTIS, PC $14.50/MF $3.50.

Results of a reconnaissance geochemical survey of the Iron River Quadrangle, Michigan; Wisconsin are reported. Field and laboratory data are presented for 357 groundwater and 346 stream sediment samples. Statistical and areal distributions of uranium and possible uranium-related variables are displayed. A generalized geologic map of the survey area is provided and pertinent geologic factors which may be of significance in evaluating the potential for uranium mineralization are briefly discussed. Groundwater data indicate that the most promising area for potential uranium mineralization occurs in Ontonagon County, Michigan. Two potential host rocks are identified: (1) the Keweenawan Oronto Group sediments, located north of the Keweenawan Fault, are spatially related to structures of the Porcupine Mountains and faults associated with the White Pine Copper Deposits; and (2) the younger Upper Keweenawan-Cambrian Jacobsville Sandstone, located south of the Keweenaw Fault. This fault thrusts Middle and Upper Keweenawan volcanic and sedimentary rocks over the younger Jacobsville Sandstone. Another area of potential mineralization is located in Baraga County, Michigan where the Jacobsville Sandstone unconformably overlies Lower Precambrian granite and gneisses and Middle Precambrian metasediments. Results of evaluation of stream-sediment data are generally inconclusive because of the diffusing effect of extensive glacial deposits, but data tend to concur generally with groundwater data. Stream-sediment data also appear to indicate felsic igneous and metamorphic rocks to be a possible source for uranium mineralization in the Iron River Quadrangle.

26934 (GJBX—116(80)(Vol.1)) **Airborne gamma-ray spectrometer and magnetometer survey: Four Corners Detail Area, portions of Kantishna River, Mt. McKinley, Medfra, and Ruby quadrangles (Alaska). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Mar 1980. Contract AC13-76GJ01664. 85p. NTIS, PC $8.50/MF $3.50.

Final data are presented from the airborne gamma-ray spectrometer and magnetometer survey of the Four Corners Detail Area, portions of Kantishna River, Mt. McKinley, Medfra, and Ruby quadrangles in Alaska.

26935 (GJBX—116(80)(Vol.2)) **Airborne gamma-ray spectrometer and magnetometer survey: Four Corners Detail Area, portions of Kantishna River, Mt. McKinley, Medfra and Ruby quadrangles (Alaska). Final report.** (Western Geophysical Co. of America, Houston, TX. Aero Service Div.). Mar 1980. Contract AC13-76GJ01664. 260p. NTIS, PC A12/MF A01.

The histograms and the multiparameter profiles are presented with the anomaly maps and flight path map.

26936 (GJBX—118(80)) **Geology and uranium evaluation of the precambrian quartz-pebble conglomerates of the Needle Mountains, Southwest Colorado. Final report.** Burns, L.K.; Ethridge, F.G.; Tyler, N.; Gross, A.S.; Campo, A.M. (Colorado State Univ., Fort Collins (USA). Dept. of Earth Resources). May 1980. Contract AC13-76GJ01664. 243p. NTIS, PC A07/MF A01.

Precambrian quartz-pebble conglomerates of the Needle Mountains of southwest Colorado are present in the Vallecito Conglomerate and the basal conglomerate of Uncompahgre Formation. Three conglomerates have lithologic, sedimentologic and mineralogic characteristics that are similar to those of the Precambrian uranium-bearing fossil placer deposits of the Witwatersrand in South Africa and the Blind River Elliot Lake district in Ontario, Canada. However, the Precambrian quartz-pebble conglomerates of Colorado do not contain the key indicator minerals of primary detrital pyrite, uraninite, and other uranium mineral species. The absence of these minerals and the structural and stratigraphic relations of these two formations suggest that they were deposited between 1780 and 1460 million years ago. These formations are, therefore, not old enough to have been deposited under the reducing atmospheric conditions thought to be necessary for the formation of placer uranium deposits. The average uranium content of the Precambrian quartz-pebble conglomerates sampled is 2.9 ppM based on analyses of 502 rock samples. Maximum values for uranium (total by neutron activation are 11 ppM for the Vallecito Conglomerate and 5.0 ppM for the basal part of the Uncompahgre Formation. The Vallecito Conglomerate contains on the average 1.2 ppM total uranium and the Uncompahgre Formation contains 1.2 ppM total uranium. These low values further indicate the low potential of these quartz-pebble conglomerates as fossil-placer uranium deposit. Uranium contents of up to 330 ppM were found in dark slates of the Uncompahgre Formation; however, these units were not closely associated with the pebble conglomerates. Some potential uranium targets of vein type and in black pelitic units are found in the Uncompahgre Formation, but these are not the fossil-placer quartz-pebble conglomerate type of deposits.

26937 (GJBX—119(80)) **Uranium isotopes in ground water as a prospecting technique.** Cowart, J.B.; Osmond, J.K. (Florida State Univ., Tallahassee (USA). Dept. of Geology). Feb 1980. Contract AC13-76GJ01664. 121p. NTIS, PC A06/MF A01.

The isotopic concentrations of dissolved uranium were determined for 300 ground water samples near eight known uranium accumulations to see if new approaches to prospecting could be developed. It is concluded that a plot of $^{234}U/^{238}U$ activity ratio (A.R.) versus uranium concentration (C) can be used to identify redox fronts, to locate uranium accumulations, and to determine whether such accumulations are being augmented or depleted by contemporary aquifer/ground water conditions. In aquifers exhibiting flow-through hydrologic systems, up-dip ground water samples are characterized by high uranium concentration values (> 1 to 4 ppB) and down-dip samples by low uranium concentration values (less than 1 ppB). The boundary between these two regimes can usually be identified as a redox front on the basis of regional water chemistry and known uranium accumulations. Close proximity to uranium accumulations is usually indicated either by very high uranium concentrations in the ground water or by a combination of high concentration and high activity ratio values. Ground waters down-dip from such accumulations often exhibit low uranium concentration values but retain their high A.R. values. This serves as a regional indicator of possible uranium accumulations where conditions favor the continued augmentation of the deposit by precipitation from ground water. Where the accumulation is being dispersed and depleted by the ground water system, low A.R. values are observed. Results from the Gulf Coast District of Texas and the Wyoming districts are presented.

26938 (GJBX—120(80)) **Utilizing the geochemical data from the National Uranium Resource Evaluation (NURE) Program: a case study of the Billings quadrangle, Montana/Wyoming.** Whitlock, J.D.; Van Eeckhout, E.M. (Montana Coll. of Mineral Science and Technology, Butte (USA)). May 1980. Contract AC13-76GJ01664;W-7405-ENG-36. 107p. NTIS, PC A06/MF A01.

Some 1665 water samples and 1426 sediment samples were collected from 1999 locations in the Billings quadrangle, Montana/Wyoming, in the summer and fall of 1978 by a private contractor for the Los Alamos Scientific Laboratory (LASL). The LASL analyzed the water samples for uranium plus 12 additional elements and the sediment samples for uranium plus 42 additional elements. The data were then released to the Montana College of Mineral Science and Technology (MCMS and T), who was responsible for the evaluation of the data to determine if there were areas appearing favorable for further investigations by the private sector. The data have subsequently been released by the LASL in an open-file report (Broxton, 1979). Statistical evaluations of the data were undertaken for uranium, copper, nickel, and chromium. Lognormal probability curves showing cumulative frequency percent versus concentration and histograms were plotted for both the water and sedime nt data for all

four elements. The probability curves and histograms indicated different data populations between the Beartooth Mountains and the rest of the quadrangle; thus the two areas were treated separately during evaluation of the data. Several areas, one along the Clarks Fork of the Yellowstone River from the town of Bridger to Laurel, another just south of Billings, and another on the northeastern side of the Pryor Mountains, are suggested as favorable for further investigations for uranium. Two areas, one south of Big Timber in the Deer Creek drainage and another along Work Creek, had a number of grouped contours, sample clusters, and individual samples with high concentrations of copper, nickel, and chromium and may deserve further study. Several tributaries of Rosebud Creek, especially Fiddler Creek, had anomalous concentrations of chromium.

26939 (GJBX—121(80)) **Uraniferous asphaltite in Moore and Potter Counties, Texas.** Handford, C.R.; Granata, G.E. (Texas Univ., Austin (USA). Bureau of Economic Geology). Jun 1980. Contract AC13-76GJ01664. 23p. NTIS, PC A02/MF A01.

Asphaltite is present in facies of the Red Cave and Panhandle lime Formation. Drill cuttings from 30 Moore County wells and 4 cores distributed across Moore and Potter Counties were examined for asphaltite. Results show that asphaltite is widespread but seems to be most abundant over structural highs, and that there is a facies control of asphaltite occurrences. In drill cuttings sandstones contain most abundant nodules yet the nodules are generally very small. Largest nodules were commonly observed in mudstone core samples. A potential exploration program should take those observations into account. Once exploitable deposits are located and if proper in situ leaching materials were developed for extraction of uranium, only sandstones could be worked. Interchannel mudstones are too impermeable and nonporous. Subsurface mining would be forced to address potential problems derived from high concentrations of hydrocarbons in the target rocks (Red Cave Formation produces oil and gas in Moore County) as well as high levels of radon (averages 100 x 10^{-12} curies per liter STP) in gas produced from the Panhandle Field.

26940 (GJBX—11780) **McDermitt and Wells 1° x 2° NTMS Areas, Nevada. Data report.** Jones, P.L.; Fay, W.M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Apr 1980. Contract AC09-76SR00001. 208p. (DPST—79-146-14). NTIS, PC $12.50/MF $3.50.

This data report presents results of stream sediment reconnaissance in the National Topographic Map Series (NTMS) McDermitt and Wells 1° x 2° quadrangles. Stream sediment samples were collected for the Lawrence Livermore Laboratory. Samples were collected at 1089 sites in the McDermitt quadrangle and at 553 sites in the Wells quadrangle. Neutron activation analysis (NAA) results are given for uranium and 16 other elements. Analytical data (U, Th, Hf; Al, Ce, Fe, Mn, Sc, Na, Ti, V; and Dy, Du, La, Lu, Sm, and Yb) are presented in tables on microfiche. Statistical summaries of data are given.

26941 (METC/EGSP—300) **Net thickness of the radioactive shale facies in the Cleveland member of the Ohio shale.** Majchszak, F.L.; Honeycutt, M. (Ohio Dept. of Natural Resources, Columbus (USA). Div. of Geological Survey). 1980. Contract AS05-76ET12131. 200p. NTIS, PC A09/MF A01.

The net thickness of radioactive shale is determined by first establishing a normal base line for each well based upon the gamma ray log response of shale units, such as the Bedford, Chagrin, and certain units within the Olentangy, observed to be fairly consistently radioactive. Radioactive shales are then defined as those shales having a gamma ray response 20 API units or more to the right of the shale base line. The combined thickness of beds reaching the radioactive shale threshold value is reported as the net thickness of radioactive shale facies within the mapping unit.

26942 (METC/EGSP—301) **Net thickness of the radioactive shale facies in the Huron and Chagrin members of the Ohio shale.** Majchszak, F.L.; Honeycutt, M. (Ohio Dept. of Natural Resources, Columbus (USA). Div. of Geological Survey). 1980. Contract AS05-76ET12131. 200p. NTIS, PC A09/MF A01.

The net thickness of radioactive shale is determined by first establishing a normal base line for each well based upon the gamma ray log response of shale units, such as Bedford, Chagrin, and certain units within the Olentangy, observed to be fairly consistently radioactive. Radioactive shales are then defined as those shales having a gamma ray response 20 API units or more to the right of the shale base line. The combined thickness of beds reaching the radioactive shale threshold value is reported as the net thickness of radioactive shale facies within the mapping unit.

26943 (METC/EGSP—303) **Net thickness of the radioactive shale facies in the lower Olentangy shale (Hamilton group).** Majchszak, F.L.; Honeycutt, M. (Ohio Dept. of Natural Resources, Columbus (USA). Div. of Geological Survey). 1980. Contract AS05-76ET12131. 200p. NTIS, PC A09/MF A01.

The net thickness of radioactive shale is determined by first establishing a normal base line for each well based upon the gamma ray log response of shale units, such as the Bedford, Chagrin, and certain units within the Olentangy, observed to be fairly consistently radioactive. Radioactive shales are then defined as those shales having a gamma ray response 20 API units or more to the right of the shale base line. The combined thickness of beds reaching the radioactive shale threshold value is reported as the net thickness of radioactive shale facies within the mapping unit. Maps are included.

26944 **Logging technique for assaying for uranium in earth formations.** Givens, W.W.; Mills, W.R. Jr. (to Mobil Oil Corp.). US Patent 4,180,730. 25 Dec 1979. Filed date 12 Jan 1978. 8p.

A borehole logging tool includes a source of fast neutrons, an epithermal neutron flux detector, and a thermal neutron flux detector. A count rate meter is connected to each detector. A ratio detector provides a signal indicative of the ratio of the count rates of the two detectors obtained during the time that prompt neutrons are emitted from neutron fission of uranium in the formation.

MINING

REFER ALSO TO CITATION(S) 27239

ENRICHMENT

GASEOUS DIFFUSION

REFER ALSO TO CITATION(S) 27361

26945 (K/ET—5015) **Purge cascade uranium monitoring.** Schultz, R.M.; Stephenson, M.J. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 7 May 1980. Contract W-7405-ENG-26. 21p. (CONF-800416—8). NTIS, PC A02/MF A01.

From UCC-ND and GAT waste management seminar program; Portsmouth, OH, USA (22 Apr 1980).

Advanced analytical instrument techniques and procedures can provide support to ensure reliable and efficient operation of the purge cascades. This information can be used, for example, to allow more effective utilization and selection of chemical trap sorbents for removing uranium hexafluoride and other purge gas components. Initial investigations indicate that gamma monitoring can be effectively used to provide unique analytical data that can aid in the overall management of uranium control processes. The preliminary results of the Oak Ridge uranium monitoring effort are summarized.

LASER EXCITATION

26946 **Isotope dissociation selective electron attachment and separation.** Chen, C.L.; Chantry, P.J. (to Westinghouse Electric Corp.). US Patent 4,176,025. 27 Nov 1979. Filed date 27 Aug 1975. 12p.

A method is described for separating isotopes in which a selected isotope of a given molecule is first excited to enhance preferential dissociative electron attachment, which facilitates the separation of the desired isotope from its natural mixture. Molecules incorporating the particular isotope of interest are selectively excited to the proper vibrational and/or electronic state by narrow line radiation to enhance preferential dissociative electron attachment. The excited molecules are then exposed to low energy electrons which dissociatively attach to the excited molecules forming stable negative ion fragments. The negative ion or neutral fragments containing the desired isotopes are then separated from the remaining mixture resulting in an enrichment of the desired isotope.

26947 **Gas dynamic reaction process and system for laser chemistry.** Garbuny, M. (to Westinghouse Electric Corp.). US Patent 4,176,024. 27 Nov 1979. Filed date 28 Jul 1975. 10p.

A reaction system is disclosed wherein a moving, unidirectional stream of an activatable gaseous species is produced, the individual members of which have the forward components of their velocities at least 10 times greater than the lateral components of their velocities. The stream is irradiated with substantially monochromatic light having a frequency which activates at least some of the individual members of the species. The activated members can then be reacted with another stream or otherwise utilized.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 27017, 27698

26948 (LA—8360-PR) **Examination of fast reactor fuels and FBR analytical quality assurance standards and methods. Progress report, January 1-March 31, 1980.** Maraman, W.J. (comp.). (Los

Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 13p. NTIS, PC A02/MF A01.

This project is directed toward the examination and comparison of the effects of neutron irradiation on LMFBR Program fuel materials. Equipment development, analytical chemistry, DRRT requests, and quality assurance are covered in this document. (DLC)

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 26975, 27013, 27015, 27028, 27029

26949 (CONF-791086—4) **Dissolution of irradiated mixed oxide fuels.** Vaughen, V.C.A.; Goode, J.H. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 23p. NTIS, PC A02/MF A01.

From US/United Kingdom information exchange on dissolution of nuclear fuel; Windscale, UK (16 Oct 1979).

The typical flowsheet for reprocessing LMFBR fuel is described. The behavior during shearing, voloxidation, and dissolution was studied with special attention paid to gaseous and solid waste streams. Fabrication and irradiation of PNL-3 fuel are discussed. The PNL-3 experiment was designed to collect statistically significant data on swelling behavior, gas release rates, and general irradiation performance of fuel pins fabricated according to the initial reference design parameters and irradiated under approximate Fast Test Reactor (FTR) conditions. Part of the study is an evaluation of how precisely ORIGEN can predict starting inventories of materials. Results from studies with PNL-3 fuel have shown that this fuel, while quite good from the standpoint of 1968 technology, is still not a soluble fuel, in our opinion. Most of the fuel dissolves very rapidly. The amount of insoluble plutonium is increased slightly by the voloxidation process, but this residual plutonium can be dissolved in a 2-hr (or less) leach with NHO_3-HF, or it can probably be dissolved using a longer leaching time in 10M HNO_3. Close agreement for plutonium isotopic concentrations with ORIGEN calculations was not found; however, the long-lived fission product concentrations were resonably well predicted by ORIGEN.

26950 (DP—1548) **Tests of alternative reductants in the second uranium purification cycle.** Thompson, M.C. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). May 1980. Contract AC09-76SR00001. 19p. NTIS, PC A02/MF A01.

Miniature mixer-settler tests of the second uranium purification cycle show that plutonium cannot be removed by hydroxylamine-hydrazine (NH_2OH-N_2H_4) because the acidity is too high, or by 2,5-di-t-pentylhydroquinone because HNO_3 oxidizes the hydroquinone. Plutonium can be removed satisfactorily when U(IV)-hydrazine is used as the reductant.

26951 (GA-A—15774) **Evaluation of a vertical continuous centrifuge for clarification of HTGR dissolver slurries.** Olguin, L.J. (General Atomic Co., San Diego, CA (USA)). Mar 1980. Contract AT03-76SF71053. 45p. (CONF-800802—6). NTIS, PC A03/MF A01.

From 89. annual meeting of the American Institute of Chemical Engineers; Portland, OR, USA (17 Aug 1980).

A series of statistically designed centrifuge performance tests was conducted to evaluate the solid-liquid separation efficiency of a vertical continuous centrifuge. Test results show that 100% of the particles greater than 4 microns in diameter were removed from simulated HTGR fuel reprocessing dissolver solutions. Centrifugal force and liquid density are the principal variables affecting separation efficiency.

26952 (NVO—219) **Safety assessment document for the spent reactor fuel calorimeter for use in the E-MAD facility at the Nevada Test Site.** (Department of Energy, Las Vegas, NV (USA). Nevada Operations Office). Jun 1980. 82p. NTIS, PC A05/MF A01.

A calorimeter has been designed to measure the decay heat generation rates of spent fuel assemblies prior to their encapsulation in the Engine Maintenance, Assembly, and Disassembly (E-MAD) facility at the Nevada Test Site. The decay heat from a spent fuel assembly is determined by immersing the assembly in boiling water contained within a closed calorimeter vessel. The calorimeter has been designed to accommodate a single PWR or BWR type fuel assembly with a decay heat generation rate in the range of 0.1 kW to 2.5 kW. The expected accuracy of decay heat measurement within the design range is +-10%. A safety assessment of the design, installation and operation of the calorimeter has been conducted.

26953 (ORNL—5566) **Actinide partitioning-transmutation program final report. I. Overall assessment.** Croff, A.G.; Blomeke, J.O.; Finney, B.C. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 151p. NTIS, PC A08/MF A01.

This report is concerned with an overall assessment of the feasibility of and incentives for partitioning (recovering) long-lived nuclides from fuel reprocessing and fuel refabrication plant radioactive wastes and transmuting them to shorter-lived or stable nuclides by neutron irradiation. The principal class of nuclides considered is the actinides, although a brief analysis is given of the partitioning and transmutation (P-T) of ^{99}Tc and ^{129}I. The results obtained in this program permit us to make a comparison of the impacts of waste management with and without actinide recovery and transmutation. Three major conclusions concerning technical feasibility can be drawn from the assessment: (1) actinide P-T is feasible, subject to the acceptability of fuels containing recycle actinides; (2) technetium P-T is feasible if satisfactory partitioning processes can be developed and satisfactory fuels identified (no studies have been made in this area); and (3) iodine P-T is marginally feasible at best because of the low transmutation rates, the high volatility, and the corrosiveness of iodine and iodine compounds. It was concluded on the basis of a very conservative repository risk analysis that there are no safety or cost incentives for actinide P-T. In fact, if nonradiological risks are included, the short-term risks of P-T exceed the long-term benefits integrated over a period of 1 million years. Incentives for technetium and iodine P-T exist only if extremely conservative long-term risk analyses are used. Further RD and D in support of P-T is not warranted.

26954 (ORNL/Sub—79/31056/1/A3) **Actinide Partitioning-Transmutation Program Final Report. V. Preconceptual designs and costs of partitioning facilities and shipping casks (appendix 3).** (Parsons (Ralph M.) Co., Pasadena, CA (USA)). Jun 1980. Contract W-7405-ENG-26. 405p. NTIS, PC A18/MF A01.

This Appendix contains cost estimate documents for the Fuels Reprocessing Plant Waste Treatment Facility. Plant costs are summarized by Code of Accounts and by Process Function. Costs contribution to each account are detailed. Process equipment costs are detailed for each Waste Treatment Process. Service utility costs are also summarized and detailed.

26955 (ORNL/Sub—79/31056/1/A4) **Actinide partitioning-transmutation program. V. Preconceptual designs and costs of partitioning facilities and shipping casks, Appendix 4. Final report.** (Parsons (Ralph M.) Co., Pasadena, CA (USA)). Jun 1980. Contract W-7405-ENG-26. 254p. NTIS, PC A12/MF A01.

This Appendix contains cost estimate documents for the Fuels Fabrication Plant Waste Treatment Facility. Plant costs are summarized by Code of Accounts and by Process Function. Costs contributing to each account are detailed. Process equipment costs are detailed for each Waste Treatment Process. Service utility costs are also summarized and detailed. Shipping cask costs are provided.

26956 (ORNL/TM—7192) **Consolidated Fuel Reprocessing Program progress report, 1 October-31 December 1979.** Unger, W.E. (comp.). (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 98p. NTIS, PC A05/MF A01.

Progress is reported in four areas: process research and development, engineering research, engineering systems, technical support, and HTGR fuel reprocessing. (DLC)

26957 (ORNL/TM—7362) **Resin bead U and PU analysis of WAK input solutions: a statistical summary of experiment No. 1.** Bayne, C.K.; Carter, J.A.; Smith, D.H.; Walker, R.L. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 45p. (ISPO—99). NTIS, PC A03/MF A01.

A statistical analysis of the resin bead experimental data was made to identify sources of variations among the measurements of isotopic atom ratios and elemental concentrations of plutonium and uranium. Comparisons among treatment means of the analytical laboratory and the resin bead preparation methods are tabulated using Duncan's multiple range test.

26958 (PNL—3359) **Laboratory studies on the evolution of iodine-129 during Purex-uranium metal dissolution.** Bray, L.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1980. Contract AC06-76RL01830. 39p. NTIS, PC A03/MF A01.

The path of iodine from the Purex dissolver was determined during fuel dissolution using ^{125}I tracer. Laboratory-scale equipment qualification studies were completed using sections of nonirradiated uranium N-reactor fuel elements. A proof-of-principle dissolution study was completed at the end of FY 1979 in the PNL hot cells using wafers of irradiated N-reactor fuel. The findings include the following: the laboratory-scale dissolver/downdraft condenser was designed at a factor of 5 x 10^{-5} of the Purex flowsheet; with no refluxing, 5.6 moles of HNO_3 were required per mole of dissolved uranium. With NO/sub x/ recovery in the reflux stream, an average of 3.6 moles of HNO_3 was required. These results formed the basis for adequate modeling of the laboratory Purex downdraft dissolver; approximately 8% of the iodine was found in the final dissolver solution when the ^{125}I tracer was added to the initial dissolver solution prior to the first cut, 6-h dissolution; when the ^{125}I was added continuously during the 6-h dissolution without any refluxing of the condenser acid back to the dissolver, approximately 16% of the iodine was found in the dissolver solution; when irradiated N-reactor fuel was dissolved while ^{125}I tracer was continuously added

to the dissolver during the 6-h test, 11% of the ^{125}I tracer was found in the dissolver solution. After 2 h of refluxing with air sparging, 6% of the ^{125}I tracer was found in the dissolver solution; and analysis of the fission product ^{129}I in the fuel duplicated the tracer study results with 8% and 7% of the iodine remaining in the dissolver solution after 6 and 8 h, respectively.

26959 (RHO-SA—149) **Decommissioning a nuclear fuel reprocessing support facility.** Held, J.T. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Jan 1980. Contract AC06-77RL01030. 10p. (CONF-800359—2). NTIS, PC A02/MF A01.

From NEA specialist meeting on decommissioning requirements in the design of nuclear facilities; Paris, France (17 Mar 1980).

Lessons learned during decontamination and dismantling of a plutonium nitrate loadout facility, highly contaminated with transuranics, suggest the development of improved design features for future nuclear fuel reprocessing plants. Part of the Hanford Redox Plant, the 233-S Building contains systems formerly used for the final purification and concentration of plutonium solutions. Specific design ideas stem from experiences in decontamination and dismantling of the 233-S Product Removal Can Loadout Facility (Loadout Hood). These ideas could influence the magnitude of future decommissioning projects.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 27009, 27019, 27594, 27595

26960 (DOE/SR-SF—20005-5) **Monthly away-from reactor spent fuel storage reort AFR program.** (Department of Energy, Aiken, SC (USA). Savannah River Operations Office). May 1980. 66p. NTIS, PC A04/MF A01.

The program covered planning and management, facility acquisition, legislative requirements, technical support, transportation, and international activities. (DLC)

26961 (LA—8237-PR) **Spent-Fuel Storage Facility Project. Progress report, June 1-September 30, 1979.** Cobb, D.D. (comp.). (Los Alamos Scientific Lab., NM (USA)). Jun 1980. Contract W-7405-ENG-36. 37p. NTIS, PC A03/MF A01.

The Los Alamos Scientific Laboratory (LASL) safeguards groups (Q-1, Q-2, Q-3, Q-4, and Q-5) and the nuclear data group (T-2) are participating in the US Department of Energy Away-From-Reactor Spent-Fuel Storage Program. This report presents the status of the LASL Spent-Fuel Storage Facility Project being performed under the direction of Savannah River Laboratory. Four task areas are: concept development, spent-fuel assay, spent-fuel verification, and automated data-base management.

26962 (ORNL/TM—7170) **Transportation analysis for the concept of regional repositories.** Joy, D.S.; Hudson, B.J. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 84p. NTIS, PC A05/MF A01.

Over the past several years, planning associated with the National Waste Terminal Storage (NWTS) program assumed the use of one or two large, centrally located repository facilities. Recently, an alternative approach has been proposed which consists of the use of multiple, smaller regional repositories. In this report, several regional concepts were studied and the transportation requirements for the shipment of spent fuel to the regional repositories were estimated. In general, the transportation requirements decrease as the number of repositories increase. However, as far as transportation is concerned, the point of diminishing returns is reached at approximately one repository in each of three to four regions. Additional savings beyond this point are small. A series of sensitivity studies is also included to demonstrate the impact on the total transportation requirements of varying cask capacity, rail speed, or truck speed. Since most of the projected fuel shipments are to be made by rail, varying the capacity of the rail cask or varying average rail transport speed will have a major effect on overall transportation requirements.

26963 (ORNL/TM—7179) **Oak Ridge National Laboratory shipping containers for radioactive materials.** Schaich, R.W. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 202p. NTIS, PC A10/MF A01.

Portions of document are illegible.

The types of containers used at ORNL for the transport of radioactive materials are described. Both returnable and non-returnable types are included. Containers for solids, liquids and gases are discussed. Casks for the shipment of uranium, irradiated fuel elements, and non-irradiated fuel elements are also described. Specifications are provided. (DC)

26964 (UCRL—52918) **Method for calculating internal radiation and ventilation with the ADINAT heat-flow code.** Butkovich, T.R.; Montan, D.N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Apr 1980. Contract W-7405-ENG-48. 17p. NTIS, PC A02/MF A01.

One objective of the spent fuel test in Climax Stock granite (SFTC) is to correctly model the thermal transport, and the changes in the stress field and accompanying displacements from the application of the thermal loads. We have chosen the ADINA and ADINAT finite element codes to do these calculations. ADINAT is a heat transfer code compatible to the ADINA displacement and stress analysis code. The heat flow problem encountered at SFTC requires a code with conduction, radiation, and ventilation capabilities, which the present version of ADINAT does not have. We have devised a method for calculating internal radiation and ventilation with the ADINAT code. This method effectively reproduces the results from the TRUMP multi-dimensional finite difference code, which correctly models radiative heat transport between drift surfaces, conductive and convective thermal transport to and through air in the drifts, and mass flow of air in the drifts. The temperature histories for each node in the finite element mesh calculated with ADINAT using this method can be used directly in the ADINA thermal-mechanical calculation.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 26954, 26955

WASTE MANAGEMENT

26965 (DOE/ET/41900—T2) **Development of tailored ceramics for geologic storage of nuclear wastes. Quarterly progress report, January 1-March 31, 1980.** (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). 15 May 1980. Contract AC09-79ET41900. 38p. NTIS. PC A03/MF A01.

In the second quarter of activities on developing Tailored Ceramic waste forms for SRP waste compositions, emphasis was on the chemistry controlling the incorporation of the waste elements into the crystalline phases of the high-alumina content ceramic and the major factors affecting the consolidation process. Research on the design and synthesis of oxide and phosphate ceramic waste forms has continued with emphasis on fluorite-structure oxides and on rare earth phosphates with the monazite structure. Dissolution studies to date indicate that monazite is very stable.

26966 (DOE/SR-WM—79-3(Rev.4/80)) **Long-term high-level waste technology program.** (Department of Energy, Aiken, SC (USA). Savannah River Operations Office). Apr 1980. 43p. NTIS, PC A03/MF A01.

The Department of Energy (DOE) is conducting a comprehensive program to isolate all US nuclear wastes from the human environment. The DOE Office of Nuclear Energy - Waste (NEW) has full responsibility for managing the high-level wastes resulting from defense activities and additional responsiblity for providing the technology to manage existing commercial high-level wastes and any that may be generated in one of several alternative fuel cycles. Responsibilities of the Three Divisions of DOE-NEW are shown. This strategy document presents the research and development plan of the Division of Waste Products for long-term immobilization of the high-level radioactive wastes resulting from chemical processing of nuclear reactor fuels and targets. These high-level wastes contain more than 99% of the residual radionuclides produced in the fuels and targets during reactor operations. They include essentially all the fission products and most of the actinides that were not recovered for use.

26967 (DP—79-125-2) **Waste management program. Technical progress report, April-June 1979.** (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Plant). May 1980. Contract AC09-76SR00001. 37p. NTIS, PC A03/MF A01.

This quarterly report provides current information on operations and development programs for the management of radioactive wastes from the operation of the Savannah River Plant. The operational status and research progress are reported for the liquid waste treatment and storage facilities, the incinerator for solid waste, the solidification of waste in borosilicate glass, and siting of subsurface storage facilities.

26968 (DPST—78-150-1) **Gas production from alpha radiolysis of concrete containing tru incinerator ash. Progress report 1, April 1-July 31, 1978.** Bibler, N.E. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1978. Contract AC09-76SR00001. 22p. NTIS, PC A02/MF A01.

This is the first progress report of an experimental study of gas evolution from alpha radiolysis of concrete containing ash from the incineration of transuranic (TRU) waste. During this experimental period, concretes containing simulated TRU incinerator ash were prepared from high alumina cement (HAC), from Portland Type I cement (I), and from Portland Type I pozzolanic cement (I-P).

^{238}Pu, an intense alpha emitter, was added to the concretes to produce radiolysis. Then, gas pressures were monitored, and gas compositions were determined. Only hydrogen was produced; its production was calculated as molecules per 100 eV of alpha energy absorbed. This quantity, $G(H_2)$, can be used to calculated H_2 production rates from acutal waste. Based on values of $G(H_2)$ determined in this period (0.30 to 0.65 molecules/100 eV), production rates would range from 660 to 1400 cm^3 of H_2 at STP per year for each curie of alpha activity. Other results were: (1) lowest values for $G(H_2)$ were obtained with concrete made from high alumina content; (2) the presence of ash in the concrete increased $G(H_2)$; (3) no effect of dose rate on $G(H_2)$ in the range 1.0×10^{16} to 1.2×10^{17} eV/min/g of concrete was detected; (4) there was also no effect on $G(H_2)$ of the pH of the water used to make the concrete; (5) presence of an organic complexing agent in the concrete decreased $G(H_2)$ and caused O_2 to be radiolytically consumed; and (6) lowering the water content, heating the concrete, lowered the $G(H_2)$.

26969 (PNL—3000-4) **Nuclear waste management. Quarterly progress report, October-December 1979.** Platt, A.M.; Powell, J.A. (comps.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract EY-76-C-06-1830. 101p. NTIS, PC A06/MF A01.

Progress and activities are reported on the following: high-level waste immobilization, alternative waste forms, nuclear waste materials characterization, TRU waste immobilization programs, TRU waste decontamination, krypton solidification, thermal outgassing, iodine-129 fixation, monitoring of unsaturated zone transport, well-logging instrumentation development, mobile organic complexes of fission products, waste management system and safety studies, assessment of effectiveness of geologic isolation systems, waste/rock interactions technology, spent fuel and fuel pool integrity program, and engineered barriers. (DLC)

WASTE PROCESSING

REFER ALSO TO CITATION(S) 26953, 26954, 26955, 27013

26970 (DPSTD—77-13-3) **Preliminary technical data summary No. 3 for the Defense Waste Processing Facility.** Landon, L.F. (comp.). (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). May 1980. Contract AC09-76SR00001. 614p. NTIS, PC A99/MF A01.

This document presents an update on the best information presently available for the purpose of establishing the basis for the design of a Defense Waste Processing Facility. Objective of this project is to provide a facility to fix the radionuclides present in Savannah River Plant (SRP) high-level liquid waste in a high-integrity form (glass). Flowsheets and material balances reflect the alternate CAB case including the incorporation of low-level supernate in concrete. (DLC)

26971 (DPSTD—79-34) **Beta-gamma contaminated solid waste incinerator facility.** Hootman, H.E. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Oct 1979. Contract AC09-76SR00001. 77p. NTIS, PC A05/MF A01.

This technical data summary outlines a reference process to provide a 2-stage, 400 lb/hour incinerator to reduce the storage volume of combustible process waste contaminated with low-level beta-gamma emitters in response to DOE Manual 0511. This waste, amounting to more than 200,000 ft^3 per year, is presently buried in trenches in the burial ground. The anticipated storage volume reduction from incineration will be a factor of 20. The incinerator will also dispose of 150,000 gallons of degraded solvent from the chemical separations areas and 5000 gallons per year of miscellaneous nonradioactive solvents which are presently being drummed for storage.

26972 (ENICO—1040) **Vitrification of high-level alumina nuclear waste.** Brotzman, J.R. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). Jun 1980. Contract AC07-79ID01675. 23p. NTIS, PC A02/MF A01.

Borosilicate and borophosphate glass compositions have been developed to vitrify simulated high-alumina calcined nuclear defense waste. The effects of the alkali (Li_2O,Na_2O) to borate ratio and the Li_2O to Na_2O ratio on the glass melt viscosity and leach resistance were measured. The effects on the same properties of substituting CaO and P_2O_5 for SiO_2 and of substituting SiO_2, P_2O_5 and CuO for B_2O_3 were measured in the borosilicate and borophosphate glass, respectively.

26973 (K/ET—5017) **Solid waste disposal study.** McGinnis, C.P.; Housley, D.A. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 21 May 1980. Contract W-7405-ENG-26. 17p. NTIS, PC A02/MF A01.

Solidification studies conducted on sludge from the K-1407C Retention Basin confirm that cement fixation is a viable method for disposal of waste solids. A model is presented relating cement requirements and sludge moisture level to the final storage volume required for cement fixation. The sludge volume and ultimate disposal cost are strongly related to the moisture of the processed sludge. Dewatering efforts with the sludge using polymer dewatering aides and centrifugation are discussed.

26974 (LA-UR—80-1428) **Controlled-air incineration of alpha-bearing solid wastes.** Koenig, R.A.; Draper, W.E.; Neuls, A.S.; Newmyer, J.M. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 23p. (CONF-800611—8). NTIS, PC A02/MF A01.

From International symposium on the management of alpha-contaminated wastes; Vienna, Austria (2 Jun 1980).

The Los Alamos Scientific Laboratory is completing a study of controlled-air incineration (CAI) as a technique for volume reduction and stabilization of combustible transuranic-contaminated solid wastes. To demonstrate feasibility, a process has been assembled and operated on synthetic and contaminated combustibles. This paper summarizes the CAI project history, process design, provisions for radioactive operation, experimental results to date, and future plans. Achievements include operation at the design feed rate as well as combustion of separate feed compositions including cellulosics, polyethylene, polyvinyl chloride (PVC) and latex rubber. Refractory life has been satisfactory to date, with studies continuing. The offgas cleanup system has proven to be extremely effective; the final high-efficiency filters showing virtually no pressure drop increase. The ability of the system to process high concentrations of PVC has been demonstrated with no chloride-induced degradation detected. Chloride and sulfate removal from the offgas has been excellent with concentrations reaching 8 and 10 ppM maximum, respectively, in the process condensate.

26975 (ORNL/Sub—80/31038/1) **Actinide partitioning-transmutation program. Final report. VII. Long-term risk analysis of the geologic repository (appendix).** Logan, S.E.; Conarty, R.L.; Ng, H.S.; Rahal, L.J.; Shirley, C.G. (Los Alamos Technical Associates, Inc., NM (USA)). Jan 1980. Contract W-7405-ENG-26. 612p. NTIS, PC A99/MF A01.

The Chemical Technology Division of ORNL has prepared a set of documents that evaluate a partitioning-transmutation (PT) fuel cycle relative to a reference cycle employing conventional fuel-material recovery methods. The PT cycle uses enhanced recovery methods so that most of the long-lived actinides are recycled to nuclear power plants and transmuted to shorter-lived materials, thereby reducing waste toxicity. Data pertaining to the long-term risk analysis of waste generated from the PT fuel cycle are presented. (DC)

26976 (PNL—2622) **Assessment of water/glass interactions in waste glass melter operation.** Postma, A.K.; Chapman, C.C.; Buelt, J.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract AC06-76RL01830. 88p. NTIS, PC A05/MF A01.

A study was made to assess the possibility of a vapor explosion in a liquid-fed glass melter and during off-standard conditions for other vitrification processes. The glass melter considered is one designed for the vitrification of high-level nuclear wastes and is comprised of a ceramic-lined cavity with electrodes for joule heating and processing equipment required to add feed and withdraw glass. Vapor explosions needed to be considered because experience in other industrial processes has shown that violent interactions can occur if a hot liquid is mixed with a cooler, vaporizable liquid. Available experimental evidence and theoretical analyses indicate that destructive glass/water interactions are low probability events, if they are possible at all. Under standard conditions, aspects of liquid-fed melter operation which work against explosive interactions include: (1) the aqueous feed is near its boiling point; (2) the feed contains high concentrations of suspended particles; (3) molten glass has high viscosity (greater than 20 poise); and (4) the glass solidifies before film boiling can collapse. While it was concluded that vapor explosions are not expected in a liquid-fed melter, available information does not allow them to be ruled out altogether. Several precautionary measures which are easily incorporated into melter operation procedures were identified and additional experiments were recommended.

26977 (PNL—3343) **High-temperature vitrification of Hanford residual-liquid waste in a continuous melter.** Barnes, S.M. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract AC06-76RL01830. 39p. NTIS, PC A03/MF A01.

Over 270 kg of high-temperature borosilicate glass have been produced in a series of three short-term tests in the High-Temperature Ceramic Melter vitrification system at PNL. The glass produced was formulated to vitrify simulated Hanford residual-liquid waste. The tests were designed to (1) demonstrate the feasibility of utilizing high-temperature, continuous-vitrification technology for the immobilization of the residual-liquid waste, (2) test the airlift draining technique utilized by the high-temperature melter, (3) compare glass produced in this process to residual-liquid glass produced under laboratory conditions, (4) investigate cesium volatility from the melter during waste processing, and (5) determine the maximum

residual-liquid glass production rate in the high-temperature melter. The three tests with the residual-liquid composition confirmed the viability of the continuous-melting vitrification technique for the immobilization of this waste. The airlift draining technique was demonstrated in these tests and the glass produced from the melter was shown to be less porous than the laboratory-produced glass. The final glass produced from the second test was compared to a glass of the same composition produced under laboratory conditions. The comparative tests found the glasses to be indistinguishable, as the small differences in the test results fell within the precision range of the characterization testing equipment. The cesium volatility was examined in the final test. This examination showed that 0.44 wt % of the cesium (assumed to be cesium oxide) was volatilized, which translates to a volatilization rate of 115 mg/cm^2-h.

26978 (PNL—3375) **Engineering-scale vitrification of commercial high-level waste.** Bonner, W.F.; Bjorklund, W.J.; Hanson, M.S.; Knowlton, D.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract AC06-76RL01830. 40p. NTIS, PC A03/MF A01.

To date, technology for immobilizing commercial high-level waste (HLW) has been extensively developed, and two major demonstration projects have been completed, the Waste Solidification Engineering Prototypes (WSEP) Program and the Nuclear Waste Vitrification Project (NWVP). The feasibility of radioactive waste solidification was demonstrated in the WSEP program between 1966 and 1970 (McElroy et al. 1972) using simulated power-reactor waste composed of nonradioactive chemicals and HLW from spent, Hanford reactor fuel. Thirty-three engineering-scale canisters of solidified HLW were produced during the operations. In early 79, the NWVP demonstrated the vitrification of HLW from the processing of actual commercial nuclear fuel. This program consisted of two parts, (1) waste preparation and (2) vitrification by spray calcination and in-can melting. This report presents results from the NWVP.

26979 (RFP—3013) **Data acquisition and control instrumentation for fluidized bed incineration system.** Tosney. W.F.; Johnson, A.J. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 20 Jun 1980. Contract AC04-76DP03533. 13p. NTIS, PC A02/MF A01.

A fluidized bed incinerator facility utilizing in situ neutralization of acid gases that are generated has been designed, constructed, and is now in operation. Computer process control and data acquisition are provided by an on-line minicomputer that has been integrated successfully with the incineration system. Analog controllers also are used at specific control points for intrasystem interaction.

26980 (RFP—3030) **Fluidized bed incineration of transuranic waste.** (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1980. Contract AC04-76DP03533. 12p. (CONF-800611—7). NTIS, PC A02/MF A01.

From International symposium on the management of alpha-contaminated wastes; Vienna, Austria (2 Jun 1980).

Fluidized bed incineration has been developed and is being evaluated at the Rocky Flats Plant (RFP) as an alternative to conventional incineration for processing transuranic (TRU) combustible waste. Fluidized bed technology development at RFP began in 1970. Laboratory and bench-scale equipment was used to determine basic fluidizing characteristics and parameters. Sufficient information was obtained so that by 1974, a metal vessel system with a 9 kh/hour (20 lb/hour) throughput was built. Operating success was rapidly achieved and in 1975 a decision was made to scale-up this 9 kg/hour pilot plant to a full scale 82 kg/hour (180 lb/hour) facility. In the subsequent four years, the process was developed beginning with a system analysis including mass and energy balances, process layouts, operating constraints and flow diagrams. Engineering uncertainties in the larger scale equipment and processes were identified, and an integrated laboratory development program was initiated to solve specific scale-up problems. Detailed engineering design then proceeded, followed by construction. By the summer of 1978, the facility was installed and component and systems testing begun. By the summer of 1979, the facility achieved its operational goal of 100 continuous hours of operation including 16 hours of operation on contaminated waste.

26981 (RHO-SA—145) **Removal of radionuclides from the water-soluble fraction of Hanford Nuclear Defense Wastes.** Strachan, D.M.; Schulz, W.W. (Battelle Pacific Northwest Labs., Richland, WA (USA); Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). Feb 1980. Contract AC06-77RL01030. 33p. (CONF-800313—8). NTIS, PC A03/MF A01.

From Waste management conference; Tucson, AZ, USA (10 Mar 1980).

The current Hanford Waste Management Program has operated since 1968 to remove the bulk of the long-lived heat emitters ^{90}Sr and ^{137}Cs from stored high-level wastes. The liquid waste remaining after removal of ^{90}Sr and ^{137}Cs is returned to underground tanks for eventual evaporation to damp solid salt cake. Hanford salt cake is an admixture of large amounts of $NaNO_3$ with minor amounts of $NaAl(OH)_4$, Na_2CO_3, Na_3CrO_4, Na_3PO_4, Na_2SO_4, and NaOH. Small amounts of ^{90}Sr, ^{137}Cs, ^{99}Tc and other radionuclides are also associated with the salt cake. Results of successful bench-scale radionuclide removal tests with various actual salt cakes and certain liquid waste solutions representative of residual liquids were reported earlier. This paper describes conditions and results of recent hot cell tests of the complete Hanford Radionuclide Removal Process. These advanced tests, made with actual residual liquid containing large concentrations of ethylenediaminetetraacetic acid (EDTA) and other organic compounds, provided a rigorous and convincing proof of the process flowsheet.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 26960, 26962, 27239, 27523, 27672, 27744, 27861, 27993

26982 (DPE—3519) **Report of conceptual design for TRU solid waste facilities adjacent to 200H Area: Savannah River Plant.** (Du Pont de Nemours (E.I.) and Co., Wilmington, DE (USA). Engineering Dept.). Feb 1978. Contract AC09-76SR00001. 564p. NTIS, PC A24/MF A01.

Facilities for consolidating Savannah River Plant solid transuranic (TRU) waste and placing in long-term safe, retrievable storage have been designed conceptually. A venture guidance appraisal of cost for the facilities has been prepared. The proposed site of the new processing area is adjacent to existing H Area facilities. The scopes of work comprising the conceptual design describe facilities for: exhuming high-level TRU waste from buried and pad-stored locations in the plant burial ground; opening, emptying, and sorting waste containers and their contents within shielded, regulated enclosures; volume-reducing the noncombustibles by physical processes and decontaminating the metal waste; burning combustibles; fixing the consolidated waste forms in a concrete matrix within a double-walled steel container; placing product containers in a retrievable surface storage facility adjacent to the existing plant burial ground; and maintaining accountability of all special nuclear materials. Processing, administration, and auxiliary service buildings are to be located adjacent to existing H Area facilities where certain power and waste liquid services will be shared.

26983 (ENICO—1031) **Fourth Calcined Solids Storage Facility. Final safety analysis report.** Schindler, R.E. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). Feb 1980. Contract AC07-79ID01675. 90p. NTIS, PC A05/MF A01.

This safety analysis report describes the Fourth Calcined Solids Storage Facility and presents the results of a safety evaluation of the facility including a design basis accident. The Idaho Chemical Processing Plant (ICPP) is a multi-purpose facility for recovering enriched U-235 from a wide variety of spent reactor fuels. Solvent extraction processes employed in recovery of fissile materials generate radioactive liquid wastes containing nuclear fission products. These liquid wastes are stored for several years in cooled, stainless steel tanks to allow decay of most short-lived radionuclides prior to calcination. In the Waste Calcining Facility (WCF), liquid waste are atomized in a hot-air-fluidized-bed of granular solids. A New Waste Calcining Facility (NWCF) is being designed to replace the WCF. The Fourth Calcined Solids Storage Facility will receive solids from the NWCF. There are currently three calcined solids storage facilities in service at ICPP; two are full and the third is being filled. The Fourth Calcined Solids Storage Facility provides an additional 17,000 ft^3 of storage. The new facility is similar to the existing facilities and will not alter appreciably the low risk level associated with existing storage of calcined solids. Double containment of the calcined solids is provided in three 12-ft diameter, 50-ft high, stainless steel bins enclosed in a reinforced concrete vault as shown. The facility is designed to withstand effects of local natural catastrophies, viz. flood, tornado and earthquake. Decay heat will be removed from the vault by conduction through the vault walls to the surrounding air and soil. During the first few years of facility use, supplementary cooling will be provided by the natural convection of cooling air through the vault. The new facility is similar to the existing calcined solids storage facilities; however, the number of bins is reduced from seven to three.

26984 (GJBX—122(80)) **Plutonium waste crib logging using the prompt fission neutron uranium logging system.** Barnard, R.W.; Stephenson, W.A. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 48p. (SAND—79-2131). NTIS, PC A03/MF A01.

Sandia Laboratories' Uranium Logging Project has demonstrated their prompt fission neutron (PFN) logging system at the Hanford, WA, site for Rockwell-Hanford Operations (RHO). The dates of the demonstration were July 31 through August 2, 1979. The purpose was to show RHO the capabilities of the system for measuring plutonium concentration. An underground effluent disposal crib associated with their processing facilities was used as the test site. The performance criterion was to be able to detect a 10

nCi/g concentration of plutonium. Six test wells penetrating the crib were logged, as were three other wells. The PFN tool was able to maintain a good signal-to-noise ratio even under the most extreme conditions of high count rate and high background. The wells at the center of the crib indicated very high concentrations of plutonium, while those at the periphery indicated much less. Concentrations estimated to be lower than 10 nCi/g were detected. Comparisons with core data were not made. The technique used to obtain physical samples for analysis did not follow uranium-exploration coring practice so comparisons were not possible. The data interpretation model used was originally developed for uranium and was modified to calculate plutonium concentration. Results indicated that the operation of a PFN logging system by RHO personnel would provide a suitable technique for monitoring transuranic waste storage sites.

26985 (LBL—7061) **Calculated thermally induced displacements and stresses for heater experiments at Stripa, Sweden. Linear thermoelastic models using constant material properties.** Chan, T.; Cook, N.G.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA). Dept. of Materials Science and Mineral Engineering). Dec 1979. Contract W-7405-ENG-48. 133p. (SAC—22). NTIS, PC A07/MF A01.

Thermally induced displacements and stresses have been calculated by finite element analysis to guide the design, operation, and data interpretation of the in situ heating experiments in a granite formation at Stripa, Sweden. There are two full-scale tests with electrical heater canisters comparable in size and power to those envisaged for reprocessed high level waste canisters and a time-scaled test. To provide a simple theoretical basis for data analysis, linear thermoelasticity was assumed. Constant (temperature-independent) thermal and mechanical rock properties were used in the calculations. These properties were determined by conventional laboratory testing on small intact core specimens recovered from the Stripa test site. Two-dimensional axisymmetric models were used for the full-scale experiments, and three-dimensional models for the time-scaled experiment. Highest compressive axial and tangential stresses are expected at the wall of the heater borehole. For the 3.6 kW full-scale heated experiment, maximum compressive tangential stress was predicted to be below the unconfined compressive strength of Stripa granite, while for the 5 kW experiment, the maximum was approximately equal to the compressive strength before the concentric ring of eight 1 kW peripheral heaters was activated, but would exceed that soon afterwards. Three zones of tensile thermomechanical stresses will occur in each full-scale experiment. Maximum vertical displacements range from a fraction of a millimeter over most of the instrumented area of the time-scaled experiment to a few millimeters in the higher-power full-scale experiment. Radial displacements are typically half or less than vertical displacements. The predicted thermomechanical displacements and stresses have been stored in an on-site computer to facilitate instant graphic comparison with field data as the latter are collected.

26986 (LBL—10193(Rev.)) **Thermomechanical modeling and data analysis for heating experiments at Stripa, Sweden.** Chan, T.; Littlestone, N.; Wan, O. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 11p. (CONF-800507—7(Rev.)). NTIS, PC A02/MF A01.

From Rock mechanics symposium; Rolla, MO, USA (27 May 1980).

Comparisons were made between predicted and measured thermomechanical displacements and stresses for in situ heating experiments at a depth of 340 m in a granite body at Stripa, Sweden. We found that taking into account the temperature dependence of the thermal expansion coefficient and the mechanical properties of the rock substantially improves the agreement between theory and experiment. In general, the displacements calculated using laboratory values of rock properties agree better with field data than in the case of stresses. This may be due to the difference between in situ and laboratory rock modulus. The significance of temperature-dependent rock properties and strength to thermomechanical failure is also discussed.

26987 (LBL—10358) **Predicted and measured temperatures, displacements and stresses from the Stripa heater experiments.** Chan, T.; Hood, M.; Witherspoon, P.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1980. Contract W-7405-ENG-48. 10p. (CONF-800645—2). NTIS, PC A02/MF A01.

From Special session on nuclear waste disposal; Stockholm, Sweden (23 Jun 1980).

A summary of the results of heater experiments conducted at the Stripa Mine in Sweden is given. These results for the induced temperature, displacement and stress fields, are compared with the original predictions for these parameters which were made using both analytical and finite-element calculations assuming that the material properties of the rock remained temperature independent. Discrepancies between the measured and the predicted results are discussed. Additional calculations, based on a limited amount of laboratory data for the temperature dependence of these material properties, are described. These new predictions are found to agree better with the measured field data.

26988 (LBL—10559) **Progress with field investigations at Stripa.** Witherspoon, P.A.; Cook, N.G.W.; Gale, J.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1980. Contract W-7405-ENG-48. 62p. (SAC—27). NTIS, PC A04/MF A01.

It is generally agreed that the most practicable method of isolating nuclear wastes from the biosphere is by deep burial in suitable geologic formations. Such burial achieves a high degree of physical isolation but raises questions concerning the rate at which some of these wastes may return to the biosphere through transport by groundwater. Any suitable repository site will be disturbed first by the excavation of the repository and second by the thermal pulse caused by the radioactive decay of the wastes. To assess the effectiveness of geologic isolation it is necessary to develop the capability of predicting the response of a rock mass to such a thermal pulse. Ultimately, this requires field measurements at depths below surface and in media representative of those likely to be encountered at an actual repository. Access to a granitic rock mass adjacent to a defunct iron ore mine at Stripa in Sweden at a depth of about 350 m below surface has provided a unique opportunity to conduct a comprehensive suite of hydrological and thermo-mechanical experiments under such conditions virtually without delay. The results of these field tests have shown the importance of geologic structure and the functional dependence of the thermo-mechanical properties on temperature in developing a valid predictive model. The results have also demonstrated the vital importance of being able to carry out large scale investigations in a field test facility.

26989 (LBL—10849) **Cross-hole investigation of a rock mass subjected to heating.** Paulsson, B.N.P.; King, M.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 9p. (CONF-800645—1). NTIS, PC A02/MF A01.

From Special session on nuclear waste disposal; Stockholm, Sweden (23 Jun 1980).

A cross-hole high-frequency acoustic investigation of a granitic rock mass subjected to sustained heating is reported. Compressional and shear-wave velocity measurements along four different paths between four vertical boreholes made prior to turning on the heater, during 398 days of heating and after the heater was turned off correlated well with the presence of fracture zones, in which the fractures were closed by thermal expansion of the rock upon heating. When the rock mass cooled, the velocity measurements indicated a greater intensity of fracturing than had existed prior to heating. Laboratory compressional and shear-wave velocity measurements have been made on intact rock specimens obtained from the site and subjected to axial stress. When used to interpret the increases in velocities measured in the field upon heating the rock mass, increases in horizontal normal stresses to between 30 and 40 MPa were inferred. Increases of these magnitudes agree with stress measurements made by the other techniques. The ratio of measured compressional to shear-wave velocity appears to provide a sensitive measure of the fraction of crack porosity containing water or gas.

26990 (ONWI—74) **Suitability of Palestine salt dome, Anderson Co., Texas for disposal of high-level radioactive waste.** Patchick, P.F. (Battelle Memorial Inst., Columbus, OH (USA)). Jan 1980. Contract AC06-76RL01830. 39p. NTIS, PC A03/MF A01.

The suitability of Palestine salt dome, in Anderson County, Texas, is in serious doubt for a repository to isolate high-level nuclear waste because of abandoned salt brining operations. The random geographic and spatial occurrence of 15 collapse sinks over the dome may prevent safe construction of the necessary surface installations for a repository. The dissolution of salt between the caprock and dome, from at least 15 brine wells up to 500 feet deep, may permit increased rates of salt dissolution long into future geologic time. The subsurface dissolution is occurring at a rate difficult, if not impossible, to assess or to calculate. It cannot be shown that this dissolution rate is insignificant to the integrity of a future repository or to ancillary features. The most recent significant collapse was 36 feet in diameter and took place in 1972. The other collapses ranged from 27 to 105 feet in diameter and from 1.5 to more than 15 feet in depth. ONWI recommends that this dome be removed from consideration as a candidate site.

26991 (ORNL/TM—7310) **Statistical sensitivity analysis of a simple nuclear waste repository model.** Ronen, Y.; Lucius, J.L.; Oblow, E.M. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 75p. NTIS, PC A05/MF A01.

This report represents a preliminary step in what should be a comprehensive sensitivity analysis of the modeling of a nuclear waste repository. The purpose of the complete analysis will be to determine which modeling parameters and physical data are most important in determining key design performance criteria and then to obtain the uncertainty in the design for safety considerations. The theory for a statistical screening design methodology is developed for later use in the overall program. The theory was applied to the test case of determining the relative importance of the sensitivity of

near field temperature distribution in a single-level salt repository to modeling parameters. The exact values of the sensitivities to these physical and modeling parameters were then obtained using direct methods of recalculation. The sensitivity coefficients found to be important for the sample problem were thermal loading, distance between the spent fuel canisters and their radius. Other important parameters were those related to salt properties at a point of interest in the repository. In particular, the screening methodology singled out four parameters related to the salt as having high sensitivities: salt conductivity, heat capacity, and density, and initial temperature of salt at the point of interest. These predictions of the screening theory were confirmed by direct recalculations which also reveal the time behavior of these sensitivities. It was found that the sensitivities of thermal loading, distance between the fuel canisters, their radius and salt density and heat capacity increase (in absolute value) during the 50-year period studied. The sensitivity of the initial temperature decreases (in absolute value) whereas the sensitivity of the salt conductivity is important at the time the temperature of the salt is equal to the response temperature. It was found that nonlinearity effects of the input parameters on the responses are negligible.

26992 (PNL—3173) **Status report on LWR spent fuel IAEA leach tests.** Katayama, Y.B.; Bradley, D.J.; Harvey, C.O. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1980. Contract EY-76-C-06-1830. 59p. NTIS, PC A04/MF A01.

Spent light-water-reactor (LWR) fuel with an average burnup of 28,000 MWd/MTU was leach-tested at 25°C using a modified version of the International Atomic Energy Agency procedure. Leach rates were determined from tests conducted in five different solutions: deionized water, sodium chloride (NaCl), sodium bicarbonate ($NaHCO_3$), calcium chloride ($CaCl_2$) and Waste Isolation Pilot Plant B brine solutions. Elemental leach rates are reported based on the release of ^{90}Sr + ^{90}Y, ^{106}Ru, ^{137}Cs, ^{144}Ce, ^{154}Eu, /sup 239 + 240/Pu, ^{244}Cm and total uranium. After 467 days of cumulative leaching, the elemental leach rates are highest in deionized water. The elemental leach rates uin the different solutions generally decreased from deionized water to the 0.03M NaCl solution to the WIPP B brine solution to the 0.03M $NaHCO_3$ solution and was a factor of 20 lower in 0.015M $CaCl_2$ solution than in deionized water. The leach rates of spent fuel and borosilicate waste-glass were also compared. In sodium bicarbonate solution, the leach rates of the two waste forms were nearly equal, but the glass was increasingly more resistant than spent fuel in calcium chloride solution, followed by sodium chloride solution, WIPP B brine solution and deionized water. In deionized water the glass, based on the elemental release of plutonium and curium, was 50 to 400 times more leach resistant than spent fuel.

26993 (PNL—3326) **Leach test methodology for the Waste/Rock Interactions Technology Program.** Bradley, D.J.; McVay, G.L.; Coles, D.G. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1980. Contract AC06-76RL01830. 49p. NTIS, PC A03/MF A01.

Experimental leach studies in the WRIT Program have two primary functions. The first is to determine radionuclide release from waste forms in laboratory environments which attempt to simulate repository conditions. The second is to elucidate leach mechanisms which can ultimately be incorporated into nearfield transport models. The tests have been utilized to generate rates of removal of elements from various waste forms and to provide specimens for surface analysis. Correlation between constituents released to the solution and corresponding solid state profiles is invaluable in the development of a leach mechanism. Several tests methods are employed in our studies which simulate various proposed leach incident scenarios. Static tests include low temperature (below 100°C) and high temperature (above 100°C) hydrothermal tests. These tests reproduce nonflow or low-flow repository conditions and can be used to compare materials and leach solution effects. The dynamic tests include single-pass, continuous-flow(SPCF) and solution-change (IAA)-type tests in which the leach solutions are changed at specific time intervals. These tests simulate repository conditions of higher flow rates and can also be used to compare materials and leach solution effects under dynamic conditions. The modified IAEA test is somewhat simpler to use than the one-pass flow and gives adequate results for comparative purposes. The static leach test models the condition of near-zero flow in a repository and provides information on element readsorption and solubility limits. The SPCF test is used to study the effects of flowing solutions at velocities that may be anticipated for geologic groundwaters within breached repositories. These two testing methods, coupled with the use of autoclaves, constitute the current thrust of WRIT leach testing.

26994 (RHO-BWI-SA—43) **LANDSAT data as a basis for regional environmental assessment within the Columbia Plateau.** Leonhart, L.S.; Stephan, J.G. (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations; Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1980. Contract AC06-77RL01030. 19p. (CONF-800577—1). NTIS, PC A02/MF A01.

From 6. Canadian symposium on remote sensing; Halifax, Canada (21 May 1980).

LANDSAT data are being used to assist in classifying land cover for the purpose of providing regional environmental assessments of a 105,000 km^2 area within the Columbia Plateau region of the northwestern United States. The environmental assessment is being performed in conjunction with siting a radioactive waste terminal-storage facility within the federally operated Hanford Site in south-central Washington. Initial assessments involved classification of four contiguous LANDSAT scenes recorded over the region during the summer of 1975 and about 300 1978 high-altitude (U-2) photographs. The resulting mosaic was segregated into ten land-cover classes. The classified land-cover data were then machine-integrated with digital irrigation well-location data taken from the US Geological Survey's Ground-Water Site Inventory. The resulting groundwater multi-source data product was required by hydrologists to segregate potential artificial recharge areas from artificial groundwater discharge areas. Related studies have employed LANDSAT data and aerial imagery to identify linear structures and other geologic features which may have a significant bearing on the tectonic and/or hydrologic setting of the Columbia Plateau. Future plans call for attempts to correlate land-cover patterns with other physical and environmental parameters such as digital terrain and hydrometeorological data.

26995 (RHO-BWI-SA—51) **Technical approach to resolving issues on rock mechanics as applied to development of a nuclear waste repository in a crystalline rock formation.** Case, J.B. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Mar 1980. Contract AC06-77RL01030. 25p. (CONF-800377—1). NTIS, PC A02/MF A01.

From Meeting on radioactive waste storage in mined caverns; Stockhol, Sweden (4 Mar 1980).

This paper summarizes the technical efforts for resolving issues on rock mechanics as applied to development of a nuclear waste repository in a crystalline rock formation. This section provides background information and definitions pertinent to rock mechanics. Section 2.0 presents the rock mechanics issues related to licensing, design, and construction of a waste repository. Section 3.0 presents the technical approach to the resolution of issues and concludes that a multi-faceted approach involving principally site characterization, laboratory testing, numerical modeling and analysis, and in situ testing and monitoring is required. While this technical approach is directed to further scientific understanding and quantification of the phenomena involved accompanying the thermal heating of rock from nuclear waste, it is emphasized that formulation of a design basis for an engineered rock structure will precede the development of a large waste repository. Section 4.0 summarizes the status of resolution activities in the areas of thermomechanical effects, coupled thermal, mechanical, and hydrological phenomena, mine-induced fracturing, mine stability, and seismicity. Section 5.0 gives a concluding statement. Under the present project plans, technical activities are proceeding on multiple fronts involving field, laboratory, and numerical modeling and analysis studies of the important phenomena related to the disposal of radioactive waste in crystalline rock. The advancement of the state of the art in rock mechanics from these activities will culminate in the risk analysis and the formulation of a design basis for repositories.

26996 (RHO-SA—142) **Risk perspectives in waste management.** Rowe, W.D.; Bartfeld, C.I.; Boykin, R.F.; Wood, D.E. (American Univ., Washington, DC; Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). May 1980. Contract AC06-77RL01030. 11p. (CONF-800565—1). NTIS, PC A02/MF A01.

From TIMS/ORSA national meeting; Washington, DC, USA (4 May 1980).

The consequences of an array of events in nuclear waste management and their relative likelihoods have been addressed in many instances. The question of what these risks mean to the scientific community, to the public, and to the decision makers is as important as the risk estimates themselves. Perspectives for attaching meaning to these estimates are investigated and reported in this study.

26997 (RHO-SA—170) **Battle for nuclear power.** Nees, W.L. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). 4 Apr 1980. Contract AC06-77RL01030. 10p. (CONF-800535—2). NTIS, PC A02/MF A01.

From ASME Idaho section symposium; Idaho Falls, ID, USA (29 May 1980).

With the emotional level running so high over nuclear power these days, it is more important than ever that you communicate your ideas and information in a way that it will be heard and understood by your audience. Keep your presentation simple and to the point. As the issues surrounding nuclear change frequently, keep informed on these issues. The central area of discussion these days is high level radioactivity waste storage. Make an effort to become

informed about the technical information that is available on high level waste storage.

26998 (SAND—79-2073) **Biological studies of the US Subseabed Disposal Program.** Gomez, L.S.; Hessler, R.R.; Jackson, D.W.; Marietta, M.G.; Smith, K.L. Jr.; Talbert, D.M.; Yayanos, A.A. (Sandia National Labs., Albuquerque, NM (USA); Scripps Institution of Oceanography, La Jolla, CA (USA); Falcon Research and Development, Albuquerque, NM (USA)). Feb 1980. Contract AC04-76DP00789. 18p. NTIS, PC A02/MF A01.

The Subseabed Disposal Program (SDP) of the US is assessing the feasibility of emplacing high level radioactive wastes (HLW) within deep-sea sediments and is developing the means for assessing the feasibility of the disposal practices of other nations. This paper discusses the role and status of biological research in the SDP. Studies of the disposal methods and of the conceived barriers (canister, waste form and sediment) suggest that biological knowledge will be principally needed to address the impact of accidental releases of radionuclides. Current experimental work is focusing on the deep-sea ecosystem to determine: (1) the structure of benthic communities, including their microbial component; (2) the faunal composition of deep midwater nekton; (3) the biology of deep-sea amphipods; (4) benthic community metabolism; (5) the rates of bacterial processes; (6) the metabolism of deep-sea animals, and (7) the radiation sensitivity of deep-sea organisms. A multicompartment model is being developed to assess quantitatively the impact (on the environment and on man) of releases of radionuclides into the sea.

26999 (SAND—79-2226) **Salt Block II: description and results.** Hohlfelder, J.J. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 69p. NTIS, PC A04/MF A01.

A description of and results from the Salt Block II experiment, which involved the heating of and measurement of water transport within a large sample of rock salt, are presented. These results include the measurement of water released into a heated borehole in the sample as well as measured temperatures within the salt. Measured temperatures are compared with the results of a mathematical model of the experiment.

27000 (SAND—79-2254) **Measurements of very large deformations in potash salt in conjunction with an ongoing mining operation.** Sattler, A.R.; Christensen, C.L. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 29p. NTIS, PC A03/MF A01.

Room and pillar deformation were measured in conjunction with a relatively new type of mining operation in a southeastern New Mexico potash mine. The extraction ratio was approximately 90 percent in a first mining operation. Due to severe deformations encountered, instrumentation had to be developed/modified for these measurements. This paper concentrates on experiment design, design of special instrumentation, field installation of equipment, and presentation of the data. Measurements made include extensometers in the pillar, in the floor and ceiling in the room between pillars, absolute level measurements, floor ceiling closure, and stress (strain) measurements. Associated laboratory rock mechanics measurements of samples from the mine are being done separately. Two separate room pillar complexes were instrumented. In the first complex, floor-ceiling deformations of approximately 1 inch/day and pillar deformations around 1/2 inch/day were measured. In the second complex, instrumentation was installed while the pillar was a part of a long wall and the subsequent sequential mining (long wall-pillar with only one adjoining room on one side - pillar in the middle of room pillar complex) was observed. Data return from this operation was good.

27001 (SAND—79-2423) **Mineralogical aspects of fluid migration in the Salt Block II experiment.** Lambert, S.J. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 33p. NTIS, PC A03/MF A01.

A block of evaporite rock containing the mineral assemblage halite (88%) - polyhalite (8%) - sylvite (4%) was machined into a cylinder one meter in diameter and one meter high, and was fitted with an axial heater, thermocouples and an off-gas collection system. After about 100 days of heating, identification of mineral efflorescences at the heater hole (carnallite and bischofite) showed that a significant portion of the 111 grams of water recovered (out of around 8500 grams available in the rock) migrated as a liquid, not as a vapor. A microscopic examination of rock slices from within 15 cm of the heater hole (where the temperature was 100 to 200°C, and the gradient was 3 to 15°C/cm) revealed that: (1) fluid inclusions had migrated, but rarely across grain boundaries; (2) fluid inclusions had not been mobilized at distances greater than about 15 cm from the heater hole; and (3) intergranular liquid had been conspicuously mobilized within 15 cm of the heater hole.

27002 (SAND—80-0201) **Evaporative water loss from welded tuff.** Hadley, G.R.; Turner, J.R. Jr. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 21p. NTIS, PC A02/MF A01.

Welded tuff is one of the many candidate rocks presently being considered as a host medium for the disposal of radioactive waste. In the case where the disposal site lies above the water table, the host rock will in general be only partially saturated. This condition leads to a number of mass transfer processes of interest, including evaporative drying, two-phase water flow due to pressure gradients, capillary movement, plus others. Although these processes have all been known about for decades, it is not clear at this time what the relative importance of each is with regard to geologic media in a waste disposal environment. In particular, there seems to be no data available for tuff that would allow an investigator to sort out mechanisms. This work is intended to be a start in that direction. This paper reports the measurement of water loss rate for welded tuff at various temperatures due to the action of evaporative drying. The initial saturation was unknown, but the average initial water content was found to be 7% by weight. The resulting data show that the water loss rate declines monotonically with time at a given temperature and increases with increasing temperature as expected. Somewhat surprising, however, is the fact that over 90% of the water from a sample was lost by evaporation at room temperature within 72 hours. All the water loss data, including that taken at temperatures as high as 150°C, are explained to within a factor of two by a simple evaporation front model. The latter assumes the water is lost by the molecular diffusion of water vapor from a receding evaporation front. The motion of the evaporation front seems to depend on mass balance rather than energy balance. Capillary forces and the resulting liquid diffusion are evidently not strong enough to wash out the evaporation front, since the front model seems to fit the data well.

27003 (SAND—80-0358C) **Bell Canyon Test (BCT): cement development report.** Gulick, C.W.; Boa, J.A. Jr.; Buck, A.D. (Sandia National Labs., Albuquerque, NM (USA); Army Engineer Waterways Experiment Station, Vicksburg, MS (USA). Structures Lab.). May 1980. Contract AC04-76DP00789. 32p. (CONF-800527—5). NTIS, PC A03/MF A01.

From International BHP symposium; Columbus, OH, USA (7 May 1980).

The Borehole Plugging (BHP) materials development program which has been underway at WES under Sandia sponsorship for about five years is reviewed. Development testing data for candidate grout mixtures for the BCT plug are presented. Field batching, mixing, and placement operations are discussed. Data from field samples molded during the two plug placements include strength, expansion, compressional wave velocity, dynamic modulus, density, and porosity. Microstructure and composition are compared for grout samples at ages of a few weeks and one year.

27004 (SAND—80-0799) **Thermal properties measurements on rocksalt samples from the site of the proposed Waste Isolation Pilot Plant.** Sweet, J.N.; McCreight, J.E. (Sandia Labs., Albuquerque, NM (USA)). 13 May 1980. Contract AC04-76DP00789. 76p. NTIS, PC A05/MF A01.

Thermal conductivity, thermal expansion, and specific heat measurements have been made on a number of specimens. The specific heat measurements were made by differential scanning calorimetry and the results showed that the specific heats of both clean rocksalt samples and of dirty samples with $\leq$ 7% insoluble impurities were essentially identical to the published specific heat for pure NaCl. In the thermal expansion measurements, two distinct groups of samples were identified. The first group had average expansion coefficients in the temperature range 300 to 700°K close to that reported for pure NaCl. All the samples in this group were composed predominantly of halite, with only small amounts of other minerals or materials present. A second group of samples had expansion coefficients only $\sim$ 0.3 to 0.5 that of NaCl. The samples in this group were composed largely of polyhalite, anhydrite, or siltstone. The measurements first reported by Acton on the thermal conductivity of samples taken from a borehole at the site of the proposed nuclear waste isolation pilot plant (WIPP) near Carlsbad, NM, have been extended to include additional samples and higher temperature measurements. This is not believed to be the result of the onset of radiative thermal transport because the deviations are negative as well as positive. Infrared transmission measurements on rocksalt samples from the proposed WIPP site show no transmission in the 3 to 10 μm wavelength range for samples > 5 cm thick. Use of the estimated infrared absorption coefficient leads to the conclusion that there is little radiative heat transport for T < 800°K. All samples were dense with little or no porosity evident. On the basis of these experiments, it is concluded that the thermal conductivity of materials found at the site can be predicted to an accuracy +- 30% from knowledge of the composition and grain size of these materials.

27005 (SAND—80-0812) **Recommended analysis plan for the borehole plugging program potash core test.** Lambert, S.J. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 22p. NTIS, PC A02/MF A01.

A four-year old plugged potash core hole near the Waste Isolation Pilot Plant (WIPP) site in southeastern New Mexico has been proposed for overcoring, in order to examine the behavior of known grout mix constituents in contact with a variety of rock types during an extended grout-curing interval. This report recommends that various geochemical analyses be applied to the core samples containing both grout and rock and the interface between the two. The methods to be used include optical petrography, electron microscopy, electron probe microanalysis, x-ray diffraction, thermal analysis (TGA, DSC, DTA) with gas chromatography/mass spectrometry, and bulk chemical analysis. These analyses would allow identification of phases which have developed during grout curing, and provide evidence of reactions which may have taken place among constituents in the system grout-rock-groundwater. These reactions, and their sequence of occurrence will be compared with reactions predicted by thermodynamic modeling as the system seeks its lowest Gibbs' free energy. Identification of reactions which have the potential for compromising the integrity of a grout plug will receive special attention. Since not all such detrimental reactions can be observed directly in a human lifetime, due to kinetic inhibitions, and since a capability of time-dependent prediction of their degree of occurrence cannot be developed, thermodynamic modeling is the only known way of evaluating the long-term stability of a grout plug. The analysis of the plug-rock system will give an indication of in situ curing history of grout plug, and will allow an early occurrence of potentially detrimental reactions to be detected. Thus, this activity will be a case-study of suitability of certain grout mixtures for use in evaporites, as an example of evaluation of grouts for long-term compatability with a variety of rock types.

27006 (UCID—18666) **Brine: a computer program to compute brine migration adjacent to a nuclear waste canister in a salt repository.** Duckworth, G.D.; Fuller, M.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Jun 1980. Contract W-7405-ENG-48. 29p. NTIS, PC A03/MF A01.

This report presents a mathematical model used to predict brine migration toward a nuclear waste canister in a bedded salt repository. The mathematical model is implemented in a computer program called BRINE. The program is written in FORTRAN and executes in the batch mode on a CDC 7600. A description of the program input requirements and output available is included. Samples of input and output are given.

27007 (UCID—18700) **Numerical calculation of thermal convection in porous media in two dimensions with applications to nuclear repository design.** Maiden, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1980. Contract W-7405-ENG-48. 15p. NTIS, PC A02/MF A01.

Thermal convection induced by nuclear waste heating could be an important mechanism in the transport of radioactive nuclides to the biosphere. A computer code HP2D was developed to calculate this effect. The code calculates transient and steady state heat and fluid flow in porous media. It allows for anisotropy of hydraulic conductivities, temperature dependent fluid density and viscosity. A heat source and a variety of temperature and flow boundary conditions can be easily employed. The code solves two coupled governing equations. The time dependent heat transport is solved by an alternating direction implicit technique; and the steady state flow of water is solved by a Gauss-Seidel Poisson solver. A sample calculation of thermal convection about a repository is given.

27008 (UCRL—15252) **Conceptual model for regional radionuclide transport from a basalt repository site. Final draft, technical memorandum.** Walton, W.C.; Voorhees, M.L.; Prickett, T.A. (Camp Dresser and McKee, Inc., Champaign, IL (USA). Water Resources Div.). 23 May 1980. Contract W-7405-ENG-48. 77p. NTIS, PC A05/MF A01.

This technical memorandum was prepared to: (1) describe a typical basalt radionuclide repository site, (2) describe geologic and hydrologic processes associated with regional radionuclide transport in basalts, (3) define the parameters required to model regional radionuclide transport from a basalt repository site, and (4) develop a "conceptual model" of radionuclide transport from a basalt repository site. In a general hydrological sense, basalts may be described as layered sequences of aquifers and aquitards. The Columbia River Basalt, centered near the semi-arid Pasco Basin, is considered by many to be typical basalt repository host rock. Detailed description of the flow system including flow velocities with high-low hydraulic conductivity sequences are not possible with existing data. However, according to theory, waste-transport routes are ultimately towards the Columbia River and the lengths of flow paths from the repository to the biosphere may be relatively short. There are many physical, chemical, thermal, and nuclear processes with associated parameters that together determine the possible pattern of radionuclide migration in basalts and surrounding formations. Brief process descriptions and associated parameter lists are provided. Emphasis has been placed on the use of the distribution coefficient in simulating ion exchange. The use of the distribution coefficient approach is limited because it takes into account only relatively fast mass transfer processes. In general, knowledge of hydrogeochemical processes is primitive.

27009 (UNI—1454) **Interim report on concreted uranium fines and chips billet curing tests: a basis for resuming shipment of concreted uranium scrap billets.** Weakley, E.A. (United Nuclear Industries, Inc., Richland, WA (USA)). 2 May 1980. Contract AC06-76RL01857. 37p. NTIS, PC A03/MF A01.

Through extensive testing and analyses of the concretion process, billets and shipping conditions, it has been determined that properly cured concreted billets can be safely shipped to National Lead Company of Ohio (NLO), Fernald. During curing, billets will be dried for 26 days prior to shipment with the last 10 days between 54 to 66°C (130 to 150°F). Such dried billets can withstand temperatures up to 85°C (185°F). The maximum billet temperature that can be expected to occur in shipment is 50°C (123°F). Thus, the drying cycle becomes a burning test at temperatures which the billets will not reach during shipment to NLO.

27010 (DOE/ER/10412—2) **[Relative mobilities and transport mechanisms of trace elements during contact metamorphism of carbonate rocks]. Progress report.** (State Univ. of New York, Stony Brook (USA). Research Foundation). [nd]. Contract AC02-79ER10412. 15p. NTIS, PC A02/MF A01.

The main objective of this study is to investigate the relative mobilities and transport mechanisms of major, minor, and trace elements during the contact metamorphism of carbonate rocks. The large contrasts in chemical potentials of SiO_2, Al_2O_3, and CaO across a granitic pluton-limestone contact may induce metasomatism. In addition, rare earth and transition metal elements may act as tracers, and their redistribution during metamorphism may record convective cooling processes. The results of this study may have an application toward the problem of radioactive waste disposal and the degree to which radioactive nuclides may be expected to migrate during geologically significant periods of time.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 26975, 27577, 27578, 27687, 27692, 27694, 27700, 27725, 27746, 27883

27011 (NLCO—1164) **Feed Materials Production Center environmental monitoring annual report for 1979.** Boback, M.W.; Ross, K.N. (National Lead Co. of Ohio, Cincinnati (USA)). 1 May 1980. Contract AC05-76OR01156. 38p. NTIS, PC A03/MF A01.

This report contains environmental monitoring data collected at the Feed Materials Production Center during 1979. These data show that the discharges of radioactive contaminants from FMPC operations were only a small fraction of the Department of Energy guide levels published in DOE Manual Chapter 0524. The resulting offsite radiation exposures would, therefore, be a small fraction of the standards for uncontrolled areas. Concentrations of environmentally important nonradioactive contaminants in water and air are also reported. Results show that FMPC operations did not cause State standards for these contaminants to be exceeded.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 26983, 26992, 27576, 27697, 27698, 27861, 27863, 27876, 27877, 27878, 27894, 27895, 27896, 27897, 27898, 27899, 27900, 27951, 27952

27012 (DOE/EV—0080) **Operational accidents and radiation exposures at ERDA facilities, 1975-1977.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Environment). May 1980. 42p. NTIS, PC A03/MF A01.

The Energy Research and Development Administration (ERDA) accident frequency and losses were similar to that of the Atomic Energy Commission (AEC) from 1970 through 1974. The ERDA incidence rates per 200,000 work hours were 1.05 for lost workday injuries and 17.8 for workdays lost. These rates are about one-third of the national industrial averages reported by the National Safety Council (NSC). Ten fatalities occurred at ERDA facilities resulting in an average annual rate of three deaths per 100,000 workers compared to the national rate of 14 deaths per 100,000 workers. ERDA's total property loss from 1975 to 1977 was $11.9 million; $1.8 million caused by fires. The average annual loss rates, in cents loss per $100 valuation, were 1.15 for non-fire and 0.18 for fire. These rates are higher than the AEC post; Rocky Flats period (1970 through 1974) which were 0.60 non-fire and 0.10 fire; but are lower than the average annual rates which were 2.4 non-fire and 1.7 fire for the entire history of the AEC. Accidents causing more than $50,000 in property damage are tabulated. ERDA continued to make a strong effort to eliminate unnecessary radiation exposure to workers.

The number of employees exceeding 1 rem decreased from 2999 in 1975 to 2274 in 1977. The two appendixes include criteria for accident investigations and summaries of accident investigation reports.

27013 (ORNL/Sub—80/31048/1) **Actinide partitioning-transmutation program final report. VI. Short-term risk analysis of reprocessing, refabrication, and transportation: appendix.** Fullwood, R.R.; Jackson, R. (Science Applications, Inc., Palo Alto, CA (USA)). Jan 1980. Contract W-7405-ENG-26. 355p. (SAI—099-78-PA). NTIS, PC A16/MF A01.

The Chemical Technology Division of the Oak Ridge National Laboratory has prepared a set of documents that evaluate a Partitioning-Transmutation (PT) fuel cycle relative to a Reference cycle employing conventional fuel-material recovery methods. The PT cycle uses enhanced recovery methods so that most of the long-lived actinides are recycled to nuclear power plants and transmuted to shorter-lived materials, thereby reducing the waste toxicity. This report compares the two fuel cycles on the basis of the short-term radiological and nonradiological risks they present to the public and to workers. The accidental radiological risk to the public is analyzed by estimating the probabilities of sets of accidents; the consequences are calculated using the CRAC code appropriately modified for the material composition. Routine radiological risks to the public are estimated from the calculated release amounts; the effects are calculated using the CRAC code. Radiological occupational risks are determined from prior experience, projected standards, and estimates of accident risk. Nonradiological risks are calculated from the number of personnel involved, historical experience, and epidemiological studies. The result of this analysis is that the short-term risk of PT is 2.9 times greater than that of the Reference cycle, primarily due to the larger amount of industry. This conclusion is strongly dominated by the nonradiological risk, which is about 150 times greater than the radiological risk. The absolute risk as estimated for the fuel cycle portions considered in this report is 0.91 fatalities/GWe-year for the PT cycle and 0.34 fatalities/GWe-year for the Reference cycle. This should be compared with Inhaber's esimate of 1.5 for nuclear and 150 for coal. All of the risks assumed here are associated with the production of one billion watts of electricity (GWe) per year.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 26961, 27227, 27228, 27229, 27230, 27231, 27232, 27233, 27536

27014 (CONF-800655—15) **Enhancement of kalman filter single loss detection capability.** Morrison, G.W.; Downing, D.J.; Pike, D.H. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 10p. NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

A new technique to significantly increase the sensitivity of the Kalman filter to detect one-time losses for nuclear marterial accountability and control has been developed. The technique uses the innovations sequence obtained from a Kalman filter analysis of a material balance area. The innovations are distributed as zero mean independent Gaussion random variables with known variance. This property enables an estimator to be formed with enhanced one time loss detection capabilities. Simulation studies of a material balance area indicate the new estimator greatly enhances the one time loss detection capability of the Kalman filter.

27015 (CONF-800655—17) **Assessing the credibility of diverting through containment penetrations.** Cooley, J.N.; Swindle, D.W. Jr. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 11p. NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

A viable approach has been developed for identifying those containment penetrations in a nuclear fuel reprocessing plant which are credible diversion routes. The approach is based upon systematic engineering and design analyses and is applied to each type of penetration to determine which penetrations could be utilized to divert nuclear material from a reprocessing facility. The approach is described and the results of an application are discussed. In addition, the concept of credibility is developed and discussed. For a typical reprocessing plant design, the number of penetrations determined to be credible without process or piping modifications was ~ 16% of the penetrations originally identified.

27016 (LA—8212) **Application of nondestructive gamma-ray and neutron techniques for the safeguarding of irradiated fuel materials.** Phillips, J.R.; Halbig, J.K.; Lee, D.M.; Beach, S.E.; Bement, T.R.; Dermendjiev, E.; Hatcher, C.R.; Kaieda, K.; Medina, E.G. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 89p. NTIS, PC A05/MF A01.

Nondestructive gamma-ray and neutron techniques were used to characterize the irradiation exposures of irradiated fuel assemblies. Techniques for the rapid measurement of the axial-activity profiles of fuel assemblies have been developed using ion chambers and Be(γ,n) detectors. Detailed measurements using high-resolution gamma-ray spectrometry and passive neutron techniques were correlated with operator-declared values of cooling times and burnup.

27017 (LA-UR—80-1741) **Evaluation of process inventory uncertainties.** Roberts, N.J. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 17p. (CONF-800655—18). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

This paper discusses the determination of some of the process inventory uncertainties in the Fast Flux Test Facility (FFTF) process line at the Los Alamos Scientific Laboratory (LASL) Plutonium Processing Facility (TA-55). A brief description of the FFTF process is given, along with a more detailed look at the peroxide precipitation and re-dissolution (PR) process. Emphasis is placed on the identification of the product and sidestreams from the unit processes, as they have application to the accountability measurements. The method of measurement of each of the product and sidestreams and their associated uncertainties are discussed. Some typical data for the PR process are presented, along with a discussion of the data. The data presented are based on our operating experience, and data on file in the TA-55 Nuclear Material Accountability System (PF/LASS/.

27018 (LA-UR—80-1795) **Microcomputer based shelf system to monitor special nuclear materials in storage.** Nicholson, N.; Kuckertz, T.H.; Ethridge, C.D. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 22p. (CONF-800655—9). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

Diversion of special nuclear material has become a matter of grave concern in recent years. Large quantities of this material are kept in long-term storage and must be inventoried periodically, resulting in a time-consuming activity that exposes personnel to additional radiation. A system that provides continuous surveillance of stored special nuclear materials has been developed. A shelf monitor has been designed using a single component microcomputer to collect data from a Geiger Muller tube that monitors gamma emissions and a scale that monitors the total weight of the special nuclear material and its container. A network of these shelf monitors reports their acquired data to a minicomputer for analysis and storage. Because a large number of these monitors is likely to be needed in most storage facilities, one objective of this program has been to develop a low cost but reliable monitor.

27019 (LA-UR—80-1797) **Scintillator spent fuel monitor.** Moss, C.E.; Nixon, K.V.; Bernard, W. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 10p. (CONF-800655—7). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

A monitor for rapidly measuring the gross gamma-ray flux immediately above spent fuel assemblies in underwater storage racks has been developed. It consists of a plastic scintillator, photomultiplier, collimator, and a small battery-powered electronics package. The crosstalk from an isolated fuel assembly to an adjacent void is only about 2%. The mean difference between the measured gamma-ray flux and the flux estimated from the declared burnup and cooling time with a simple formula is 22%.

27020 (LA-UR—80-1815) **Nuclear safeguards applications of energy-dispersive absorption edge densitometry.** Russo, P.A.; Hsue, S.T.; Langner, D.G.; Sprinkle, J.K. Jr. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 44p. (CONF-800655—11). NTIS, PC A03/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

The principles and techniques of absorption edge densitometry in the energy-dispersive mode are summarized as they apply to the nondestructive assay of special nuclear materials. Five existing field instruments, designed for special nuclear materials accounting measurements, are described. Results of the testing of these instruments as well as recent laboratory results are used to define the capabilities of the technique for special nuclear materials accounting. Possibilities for future applications are reviewed. 14 figures.

27021 (LA-UR—80-1816) **Implementing advanced data analysis techniques in near-real-time materials accounting.** Markin, J.T.; Baker, A.L.; Shipley, J.P. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 10p. (CONF-800655—10). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

Materials accounting for special nuclear material in fuel cycle facilities is implemented more efficiently by applying decision analysis methods, based on estimation and detection theory, to analyze process data for missing material. These methods are incorporated in the computer program DECANAL, which calculates sufficient statistics containing all accounting information, sets decision thresholds, and compares these statistics to the thresholds in testing the hypothesis H_0 of no missing material against the alternative H_1 that material is missing. DECANAL output provides alarm charts indicating the likelihood of missing material and plots of statistics that estimate materials loss. This program is a useful tool for aggregating and testing materials accounting data for timely detection of missing material.

27022 (LA-UR—80-1817) **Measurement trends for future safeguards systems.** Baloga, S.M.; Hakkila, E.A. (National Bureau of Standards, Washington, DC (USA); Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 23p. (CONF-800655—12). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

Safeguards for future commercial-scale nuclear facilities may employ three materials control and accounting concepts: classical accounting, dynamic materials balancing, and independent verification of inventories and materials balances. Typical measurement needs associated with the implementation of these concepts at high-throughput facilities are discussed. Promising measurement methods for meeting these needs are described and recent experience is cited. General directions and considerations for meeting advanced safeguards systems needs through measurement technology development over the next decade are presented.

27023 (ORNL/SUB—7605/9) **Institutional arrangements for the reduction of proliferation risks formulation, evaluation, and implementation of institutional concepts.** Kratzer, M.B.; Wonder, E.F.; Gray, J.E.; Shantzis, S.B.; Sievering, N.F.; Paige, H.W.; Jones, B.M. (International Energy Associates Ltd., Washington, DC (USA)). Dec 1979. Contract W-7405-ENG-26. 226p. NTIS, PC A11/MF A01.

The purpose of this study was to: (1) identify alternative institutional arrangements applicable to the sensitive steps in the back-end of the fuel cycle that might reduce their associated proliferation risks; and (2) assess their advantages and disadvantages from the standpoint of nonproliferation effectiveness and political, economic, and operational acceptability. The concept of international or multinational custody of sensitive materials and facilities was found to offer a high degree of proliferation resistance and to likely be more acceptable to prospective participants than other institutional arrangements that intrude upon proprietary areas, such as facility ownership and management.

27024 (ORNL/SUB—7605/9(App.)) **Institutional arrangements for the reduction of proliferation risks formulation, evaluation, and implementation of institutional concepts. Appendices.** (International Energy Associates Ltd., Washington, DC (USA)). Dec 1979. Contract W-7405-ENG-26. 131p. NTIS, PC A07/MF A01.

The purpose of this supporting analysis is to provide a foundation for developing a model, an international or multinational institution capable of accomodating the back end of the fuel cycle, while meeting US nonproliferation goals. The analysis is based on a review of selected, defunct and extant institutions which, although not necessarily concerned with nonproliferation, have faced a trade-off between acceptability and effectiveness in meeting their objectives. Discussion of the various institutions is divided into three categories: international organizations, multinational consortia, and cartels or producer associations. Examples of international organizations include the International Seabed Authority, Intelsat, the United Nations and the International Atomic Energy Agency (IAEA). The International Seabed Authority is discussed. Multinational consortia are organizations that have been developed primarily to meet common commercial objectives. Membership includes at least three member nations. Examples include the Scandinavian Airline System (SAS), URENCO, Unilever, Royal Dutch Shell, Eurochemic, Eurodif, Euratom, European Coal and Steel Community, and Serena. Cartels or producer associations are multinational agreements that restrict market forces; viz, production, market share, customers or prices. Examples include the Intergovernmental Council of Copper Exporting Countries (CIPEC), the Organization of Petroleum Exporting Countries (OPEC), and the Fifth International Tin Agreement (ITA), as well as agreements governing diamonds and uranium, bauxite and coffee. OPEC, CIPEC and ITA are discussed.

27025 (ORNL/SUB—7605/9(Exect.Summ.)) **Institutional arrangements for the reduction of proliferation risks. Formulation, evaluation, and implementation of institutional concepts.** Kratzer, M.B.; Wonder, E.F.; Gray, J.E.; Shantzis, S.B.; Sievering, N.F.; Paige, H.W.; Jones, B.M. (International Energy Associates Ltd., Washington, DC (USA)). Dec 1979. Contract W-7405-ENG-26. 82p. NTIS, PC A05/MF A01.

The purpose of this study was to: (1) identify alternative institutional arrangements applicable to the sensitive steps in the back-end of the fuel cycle that might reduce their associated proliferation risks; and (2) assess their advantages and disadvantages from the standpoint of nonproliferation effectiveness and political, economic, and operational acceptability. The concept of international or multinational custody of sensitive materials and facilities was found to offer a high degree of proliferation resistance and to likely be more acceptable to prospective participants than other institutional arrangements that intrude upon proprietary areas, such as facility ownership and management.

27026 (SAND—80-0414) **Adaptive Intrusion Data System (AIDS).** Corlis, N.E. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 24p. NTIS, PC A02/MF A01.

The adaptive intrusion data system (AIDS) was developed to collect data from intrusion alarm sensors as part of an evaluation system to improve sensor performance. AIDS is a unique data system which uses computer controlled data systems, video cameras and recorders, analog-to-digital conversion, environmental sensors, and digital recorders to collect sensor data. The data can be viewed either manually or with a special computerized data-reduction system which adds new data to a data base stored on a magnetic disc recorder. This report provides a synoptic account of the AIDS as it presently exists. Modifications to the purchased subsystems are described, and references are made to publications which describe the Sandia-designed subsystems.

27027 (SAND—80-0505C) **Evaluation methodology for fixed-site physical protection systems.** Bennett, H.A.; Olascoaga, M.T. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 8p. (CONF-800655—4). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

A system performance evaluation methodology has been developed to aid the Nuclear Regulatory Commission (NRC) in the implementation of new regulations designed to upgrade the physical protection of nuclear fuel cycle facilities. The evaluation methodology, called Safeguards Upgrade Rule Evaluation (SURE), provides a means of explicitly incorporating measures for highly important and often difficult to quantify performance factors, e.g., installation, maintenance, training and proficiency levels, compatibility of components in subsystems, etc. This is achieved by aggregating responses to component and system questionaires through successive levels of a functional hierarchy developed for each primary performance capability specified in the regulations, 10 CFR 73.45. An overall measure of performance for each capability is the result of this aggregation process. This paper provides a descripton of SURE.

27028 (SAND—80-1390C) **Containment/surveillance concepts for international safeguards in reprocessing plants.** Bleck, M.E.; Cameron, C.P.; Camp, A.L. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 14p. (CONF-800655—3). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

This paper examines the potential role of advanced containment/surveillance instrumentation systems for international safeguards in reprocessing plants. Several conceptual systems for the surveillance of containment boundary penetrations in a reference reprocessing plant are described and evaluated. The results of the evaluation aid in understanding the potential capabilities and limitations of containment/surveillance as an international safeguards concept in this type of facility.

27029 (UCRL—15243) **Modeling of fissile material diversion in solvent extraction cascades.** Schneider, A.; Carlson, R.W. (Georgia Inst. of Tech., Atlanta (USA)). 22 May 1980. Contract W-7405-ENG-48. 48p. NTIS, PC A03/MF A01.

Changes were calculated for measurable parameters of a solvent extraction section of a reprocessing plant resulting from postulated fissile material diversion actions. The computer program SEPHIS was modified to calculate the time-dependent concentrations of uranium and plutonium in each stage of a cascade. The calculation of the inventories of uranium and plutonium in each contactor was also included. The concentration and inventory histories were computed for a group of four sequential columns during start-up and for postulated diversion conditions within this group of columns. Monitoring of column exit streams or of integrated column inventories for fissile materials could provide qualitative indications of attempted diversions. However, the time delays and resulting changes are complex and do not correlate quantitatively with the magnitude of the initiating event.

27030 (UCRL—82241) **Value-impact analysis of regulations for the nuclear industry.** Al-Ayat, R.; Judd, B.; Huntsman, J. (Sandia National Labs., Albuquerque, NM (USA)). 23 Jun 1980. Contract W-7405-ENG-48. 10p. (CONF-800655—24). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

This paper summarizes a quantitative tool developed at Lawrence Livermore National Laboratory to aid the NRC in establishing Material Control and Accounting (MC and A) regulations for safeguarding Special Nuclear Material (SNM). Illustrative Value-Impact results of demonstrating the methodology at a facility handling SNM to evaluate alternative safeguards rules is given. The methodology developed also offers a useful framework for facility designers to choose safeguards measures that meet the NRC's criteria in a cost-effective manner. Furthermore, the methodology requires very modest computing capability and is straightforward to apply.

27031 (UCRL—82244) **Safeguard Vulnerability Analysis Program (SVAP).** Gilman, F.M.; Dittmore, M.H.; Orvis, W.J.; Wahler, P.S. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). 23 Jun 1980. Contract W-7405-ENG-48. 11p. (CONF-800655—23). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

This report gives an overview of the Safeguard Vulnerability Analysis Program (SVAP) developed at Lawrence Livermore National Laboratory. SVAP was designed as an automated method of analyzing the safeguard systems at nuclear facilities for vulnerabilities relating to the theft or diversion of nuclear materials. SVAP addresses one class of safeguard threat: theft or diversion of nuclear materials by nonviolent insiders, acting individually or in collusion. SVAP is a user-oriented tool which uses an interactive input medium for preprocessing the large amounts of safeguards data. Its output includes concise summary data as well as detailed vulnerability information.

27032 (CONF-800655—16) **Technique for detecting a small magnitude loss of special nuclear material.** Pike, D.H.; Chernick, M.R.; Downing, D.J. (Oak Ridge National Lab., TN (USA)). [nd]. Contract W-7405-ENG-26. 8p. NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

The detection of losses of special nuclear materials has been the subject of much research in recent years. The standard industry practice using ID/LEID will detect large magnitude losses. Time series techniques such as the Kalman Filter or CUSUM methods will detect small magnitude losses if they occur regularly over a sustained period of time. To date no technique has been proposed which adequately addresses the problem of detecting a small magnitude loss occurring in a single period. This paper proposes a method for detecting a small magnitude loss. The approach makes use of the influence function of Hempel. The influence function measures the effect of a single inventory difference on a group of statistics. An inventory difference for a period in which a loss occurs can be expected to produce an abnormality in the calculated statistics. This abnormality is measurable by the influence function. It is shown that a one period loss smaller in magnitude than the LEID can be detected using this approach.

ADMINISTRATIVE AND REGULATORY

27033 (UCID—18709) **Early identification of technical issues: a sensitivity study to check LISTRA1A internal consistency and structure.** Harvey, T.F.; Maninger, R.C.; Rabsatt, S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Dec 1979. Contract W-7405-ENG-48. 22p. NTIS, PC A02/MF A01.

This report describes a sensitivity study using LISTRA1A, a model for use in the development of a long-range, time-dependent plan for licensing nuclear waste repositories. The objectives of the model are: (1) to provide information concerning the impact of various licensing strategies on the ability to dispose of nuclear waste effectively; and (2) to provide long-range budget forecasts for differing strategies of the Nuclear Regulatory Commission (NRC) and the Department of Energy (DOE). The model is designed to analyze the interaction between NRC regulatory policy and DOE technical programs. A sensitivity study is reported for a single parameter in a hypothetical review process.

FUSION FUELS

BY-PRODUCTS

27034 (LA-UR—80-1515) **Present and future status of thermochemical cycles applied to fusion energy sources.** Booth, L.A.; Cox, K.E.; Krakowski, R.A.; Pendergrass, J.H. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 9p. (CONF-800806—16). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

This paper reviews the status of current research on thermochemical hydrogen production cycles and identifies the needs for advanced cycles and materials research. The Los Alamos Scientific Laboratory (LASL) bismuth sulfate thermochemical cycle is characterized, and fusion reactor blanket concepts for both inertial and magnetic confinement schemes are presented as thermal energy sources for process heat applications.

27035 (UCRL—84106) **Materials considerations for the coupling of thermochemical hydrogen cycles to tandem mirror reactors.** Krikorian, O.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 May 1980. Contract W-7405-ENG-48. 6p. (CONF-800806—18). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

Candidate materials are discussed and initial choices made for the critical elements in a liquid Li-Na Cauldron Tandem Mirror blanket and the General Atomic Sulfur-Iodine Cycle for thermochemical hydrogen production. V and Ti alloys provide low neutron activation, good radiation damage resistance, and good chemical compatibility for the Cauldron design. Aluminide coated In-800H and siliconized SiC are materials choices for heat exchanger components in the thermochemical cycle interface.

27036 (UCRL—84212) **Interfacing the tandem mirror reactor to the sulfur-iodine process for hydrogen production.** Galloway, T.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Jun 1980. Contract W-7405-ENG-48. 9p. (CONF-800806—13). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

The blanket is linked to the H_2SO_4 vaporization units and SO_3 decomposition reactor with either sodium or helium. The engineering and safety problems associated with these choices are discussed. This H_2SO_4 step uses about 90% of the TMR heat and is best close-coupled to the nuclear island. The rest of the process we propose to be driven by steam and does not require close-coupling. The sodium loop coupling seems to be preferable at this time. We can operate with a blanket around 1200 K and the SO_3 decomposer around 1050 K. This configuration offers double-barrier protection between Li-Na and the SO_3 process gases. Heat pipes offer an attractive alternate to provide an additional barrier, added modularity for increased reliability, and tritium concentration and isolation operations with very little thermal penalty.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 27885

WASTE MANAGEMENT

27037 (BNL—27784) **HYPERFUSE: a novel inertial confinement system utilizing hypervelocity projectiles for fusion energy production and fission waste transmutation.** Makowitz, H.; Powell, J.R.; Wiswall, R. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76-CH00016. 14p. (CONF-800446—4). NTIS, PC A02/MF A01.

From 2. international conference on emerging nuclear energy systems; Lausanne, Switzerland (8 Apr 1980).

Parametric system studies of an inertial confinement fusion (ICF) reactor system to transmute fission products from an LWR economy have been carried out. The ICF reactors would produce net power in addition to transmuting fission products. The particular ICF concept examined is an impact fusion approach termed HYPERFUSE, in which hypervelocity pellets, traveling on the order of 100 to 300 km/sec, collide with each other or a target block in a reactor chamber and initiate a thermonuclear reaction. The DT fusion fuel is contained in a shell of the material to be transmuted, e.g., ^{137}Cs or ^{90}Sr. The 14-MeV fusion neutrons released during the pellet burn cause transmutation reactions (e.g., (n, 2n), (n, α), etc.) that convert the long lived fission products (FP's) either to stable products or to species that decay with a short half-life to a stable product.

ISOTOPE AND RADIATION SOURCE

TECHNOLOGY

RADIATION SOURCES

27038 (PNL—3274) **List of DOE radioisotope customers with summary of radioisotope shipments, FY 1979.** Burlison, J.S. (comp.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76RL01830. 51p. NTIS, PC A04/MF A01.

The fifteenth edition of the radioisotope customer list was prepared at the request of the Division of Financial Services, Office of the Assistant Secretary for Environment, Department of Energy (DOE). This document lists DOE's radioisotope production and distribution activities by its facilities at Argonne National Laboratory; Pacific Northwest Laboratory; Brookhaven National Laboratory; Hanford Engineering Development Laboratory; Idaho Operations Office; Los Alamos Scientific Laboratory; Mound Facility; Oak Ridge National Laboratory; Rocky Flats Area Office; Savannah River Laboratory; and UNC Nuclear Industries, Inc. The information is divided into five sections: Isotope suppliers, facility, contracts and isotopes or services supplied; alphabetical list of customers, and isotopes purchased; alphabetical list of isotopes cross-referenced to customer numbers; geographical location of radioisotope customers; and radioisotope sales and transfers-FY 1979.

ISOTOPIC POWER SUPPLIES

27039 (GA-A—15878) **Development of an advanced RTG using segmented thermoelectrics.** Elsner, N.B.; Bass, J.C.; Russo, F.A.; O'Riordan, P.A. (Teledyne Energy Systems, Timonium, MD (USA); Department of Energy, Washington, DC (USA); General Atomic Co., San Diego, CA (USA)). May 1980. Contract AT03-76ET33004. 7p. (CONF-800806—6). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

A 10% efficient radioisotope-heated thermoelectric generator (RTG) is being developed for the Department of Energy that consists of: (1) a radiation-coupled heat source; (2) a multi-series parallel circuit; (3) a very high specific weight radiator structure fabricated with graphite fiber and epoxy; and (4) segmented thermoelectric legs. For the positive (P) leg, $(Cu,Ag)_2Se$ is segmented with $(Bi,Sb)_2(Se,Te)_3$, PbSnMnTe, or $(AgSeTe_2)_{0.15}(GeTe)_{0.85}$ (TAGS). For the negative (N) leg, $NdSe_{1.5}$ is segmented with PbTe. The operating hot temperature (H/sub H/ and cold temperature (T/sub C/) are 725°C and 150°C, respectively.

27040 (LA—8386-PR) **General-purpose heat source project and space nuclear safety fuels program. Progress report, February 1980.** Maraman, W.J. (comp.). (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 46p. NTIS, PC A03/MF A01.

This formal monthly report covers the studies related to the use of $^{238}PuO_2$ in radioisotopic power systems carried out for the Advanced Nuclear Systems and Projects Division of the Los Alamos Scientific Laboratory. The two programs involved are: General-Purpose Heat Source Development and Space Nuclear Safety and Fuels. Most of the studies discussed here are of a continuing nature. Results and conclusions described may change as the work continues. Published reference to the results cited in this report should not be made without the explicit permission of the person in charge of the work.

27041 (LA—8406-PR) **Milliwatt Generator Project. Progress report, October 1979-April 1980.** Maraman, W.J. (comp.). (Los Alamos Scientific Lab., NM (USA)). Jun 1980. Contract W-7405-ENG-36. 26p. NTIS, PC A03/MF A01.

This formal biannual report covers the effort related to the Milliwatt Generator Project (MWG) carried out for the Department of Energy, Office of Military Applications, by the Los Alamos Scientific Laboratory (LASL). Most of the studies discussed here are of a continuing nature. Results and conclusions may change as the work continues. Published reference to the results cited in this report should not be made without the explicit permission of the person in charge of the work.

HYDROGEN

PRODUCTION

ELECTROLYSIS

REFER ALSO TO CITATION(S) 27047

27042 (BNL—27457) **Hydrogen production from remote power sites.** Mezzina, A.; Grimes, G.; Reeves, R.; Wiley, R. (Brookhaven National Lab., Upton, NY (USA)). Feb 1980. Contract EY-76-C-02-0016. 10p. (CONF-800204—9). NTIS, PC A02/MF A01.

From Energy-sources technology conference; New Orleans, LA, USA (3 Feb 1980).

The basic concept for adopting small existing dams to hydrogen production entails the energy conversion steps: hydropower-to-shaft-power via a hydraulic turbine; shaft-power-to-electrical power via a generator; and electrical power-to-hydrogen (and oxygen) via a water electrolyzer. The resource availability is discussed. The concept implementation in Potsdan, New York is mentioned.

THERMOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 27034, 27036

27043 (COO—4434-14) **Assessment of thermochemical hydrogen production. Project 61010 (formerly 8994) final report, July 1, 1977-March 31, 1979.** Dafler, J.R.; Foh, S.E.; Lee, T.S.; Schreiber, J.D. (Institute of Gas Technology, Chicago, IL (USA)). May 1979. Contract EC-77-C-02-4434. 120p. NTIS, PC A06/MF A01.

The Institute of Gas Technology's (IGT) assessment of thermochemical water-splitting processes is given. Eight tasks were performed: evaluation of load-line efficiencies; hydrogen bromide electrolysis; maximum attainable thermal efficiency on a specific bromide hybrid cycle; development of electrolyzer elements for H_2SO_3; feasibility of high-temperature reference-state thermochemical cycles; interfacing characteristics - solar high-temperature heat sources; analysis of solar and solar hybrid heat sources; and laboratory assessment of cycle with high-temperature step. Engineering analyses were done on two thermochemical hydrogen production cycles - IGT's cycles B-1 and H-5. The load line efficiency for B-1 was 18.1% and for H-5 37.4%. The electrolysis of HBr (aq) on three substrates: platinum, porous graphite, and vitreous graphite was investigated. Platinum proved to be the most efficient electrode surface, with vitreous graphite showing no promise, and porous graphite showing only slightly better results. On platinum, cell voltages of under 1.0 volt were obtained at current densities up to 200 mA/cm². Five new members of the metal-metal oxide class of cycles were derived. The maximum attainable efficiencies of these high-temperature, two-step cycles range from 64 to 86%. Six high-temperature metal oxide-metal sulfate cycles were derived. Performance and capital costs data for a wide range of solar primary heat sources were tabulated.

27044 (GA-A—15777(Rev.)) **Hydrogen production by the GA sulfur-iodine process: a progress report.** Besenbruch, G.E.; McCorkle, K.H.; Norman, J.H.; O'Keefe, D.R.; Schuster, J.R.; Trester, P.W.; Yoshimoto, M. (General Atomic Co., San Diego, CA (USA)). May 1980. Contract AC02-80ET26225. 17p. (CONF-800616—6(Rev.)). NTIS, PC A02/MF A01.

From 3. world hydrogen energy conference; Tokyo, Japan (23 Jun 1980).

The progress of the overall total development effort of the General Atomic (GA) sulfur-iodine thermochemical water-splitting cycle over the last two years is summarized. The major accomplishments have been: significant improvements in the chemistry of the process; development, review, and revision of an engineering flowsheet, resulting in a thermal process efficiency of 47%; screening, identification, and testing of potential materials-of-construction for the corrosive process fluids; small-scale demonstration of the cycle in a closed loop under recycle conditions; installation of bench-scale equipment and demonstration of parts of the process in this system; and development of a conceptual, preliminary flowsheet for the GA sulfur-iodine cycle driven by solar energy. The results of the work carried out during the last two years have demonstrated that thermochemical water splitting by the sulfur-iodine cycle is a feasible process and have provided confidence that thermal efficiencies in the range of 50% are achievable.

27045 (GA-A—15788) **Thermochemical water-splitting cycle, bench-scale investigations and process engineering. Annual report, October 1, 1978-September 30, 1979.** Caprioglio, G.; McCorkle, K.H.; Besenbruch, G.E.; Rode, J.S. (General Atomic Co., San Diego, CA (USA)). Mar 1980. Contract AT03-76SF90351. 142p. NTIS, PC A07/MF A01.

A program to investigate thermochemical water splitting has been under way at General Atomic Company (GA) since October 1972. This document is an annual progress report of Department of Energy (DOE) sponsored process development work on the GA sulfur-iodine thermochemical water splitting cycle. The work consisted of laboratory bench-scale investigations, demonstration of the process in a closed-loop cycle demonstrator, and process engineering design studies. A bench-scale system, consisting of three subunits, has been designed to study the cycle under continuous flow conditions. The designs of subunit I, which models the main solution reaction and product separation, and subunit II, which models the

concentration and decomposition of sulfuric acid, were presented in an earlier annual report. The design of subunit III, which models the purification and decomposition of hydrogen iodide, is given in this report. Progress on the installation and operation of subunits I and II is described. A closed-loop cycle demonstrator was installed and operated based on a DOE request. Operation of the GA sulfur-iodine cycle was demonstrated in this system under recycle conditions. The process engineering addresses the flowsheet design of a large-scale production process consisting of four chemical sections (I through IV) and one helium heat supply section (V). The completed designs for sections I through V are presented. The thermal efficiency of the process calculated from the present flowsheet is 47%.

27046 (LA-UR—80-1467) **Solids decomposition kinetics for LASL bismuth sulfate cycle.** Peterson, C.L.; Bowman, M.G. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800806—20). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

The LASL Bismuth Sulfate Cycle includes a solid-decomposition step as an alternative to the high-temperature evaporation and decomposition of concentrated sulfuric acid, with its attendant drying and materials problems. A solids decomposition facility was constructed and used to study the handling of solid sulfates and the kinetics of their decomposition. The decomposition of $Bi_2O(SO_4)_2$ has been measured as a function of temperature and transit time through a laboratory-scale rotary kiln, constructed from quartz. Temperatures from 973 to 1143°K were investigated. The transit time was controlled by varying the slope of the kiln, its rotational speed, and the rate of feed of a bismuth oxysulfate prepared in the prescribed manner. The preparation and characterization of this solid, which has reasonable feeding properties and minimal solution retention, are described. Significant amounts of decomposition were measured in short reaction times at the temperatures investigated.

27047 (LA-UR—80-1490) **Comparison of capital cost estimates and process efficiencies for hydrogen production by thermochemical cycles and water electrolysis.** Cox, K.E. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 8p. (CONF-800806—5). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

A survey of capital cost estimates and process efficiencies for two different technologies for producing hydrogen from water has been completed. Thermochemical cycles show costs ranging from \$600 to 1100/kW H_2 while advanced methods of water electrolysis were estimated in the range of \$700 to 1100/kW H_2. In general, efficiencies for thermochemical cycles were higher at 40 to 55%, than for water electrolysis systems at 30 to 40%. In all evaluations of new technology, careful attention must be paid to the assumptions underlying the derived cost and efficiency to ensure that design conditions conform to achievable results.

27048 (LA-UR—80-1611) **Metal sulfite/sulfate reactions in thermochemical hydrogen cycles.** Mason, C.F.V.; Bowman, M.G. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800660—2). NTIS, PC A02/MF A01.

From Thermochemical hydrogen workshop; Tsukuba, Japan (18 Jun 1980).

The thermochemical cycles which have been most extensively developed all involve the thermal decomposition of sulfuric acid which is corrosive. Metal sulfate cycles have been studied as a means of circumventing handling corrosive mixtures at high temperatures. However, these metal sulfate cycles still use an electrochemical step to produce H_2. Alternate H_2 producing steps to be used in conjunction with metal sulfates are examined.

BIOSYNTHESIS AND PHOTOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 27106

STORAGE

REFER ALSO TO CITATION(S) 27440

27049 (CONF-800402—13) **Hydrides versus competing options for storing hydrogen in energy systems.** Swisher, J.H.; Johnson, E.D. (Department of Energy, Washington, DC (USA). Assistant Secretary for Conservation and Solar Energy; OAO Corp., Washington, DC (USA)). 7 Apr 1980. Contract AC01-79CS60478. 43p. NTIS, PC A03/MF A01.

From International symposium on the properties and applications of metal hydrides; Colorado Springs, CO, USA (7 Apr 1980).

Metal hydrides present many possibilities for energy storage because of their ability to store hydrogen safely and at modest pressure. We have compared hydrogen storage in metal hydrides to other forms of hydrogen storage. Comparisons have been made using technical performance, cost, and safety as the criteria. Hydrides applications and alternatives for vehicular applications, chemical heat pumps, engines, peak shaving, and others are discussed.

CHEMISORPTION

REFER ALSO TO CITATION(S) 27152, 27456

27050 (BNL—26924) **Hydride beds: engineering tests.** Rosso, M.J. Jr.; Strickland, G. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract AC02-76CH00016. 5p. NTIS, PC A02/MF A01.

Portions of document are illegible.

The BNL Hydrogen Storage Program engineering effort is directed toward finding solutions to the engineering problems associated with metal hydrides - principally FeTiH/sub x/. Measurements of thermal conductivity in non-enhanced, copper mesh-enhanced and aluminum foam-enhanced hydride beds have been made and indicate that the form of the enhancement material is the critical factor. The completion of the HYTACTS and its initial shakedown runs suggest the many applications for this new facility in the area of advanced hydrogen component testing. The performance testing of the Variable Parameter Test Unit-2 (VPTU-2) will begin following the BNL Safety Committee approval. A description of this vessel is included. The purpose, description and status of the Variable Parameter Test Unit -1 (VPTU-1) is reported as well as the results of the first set of tests performed in this vessel.

27051 (CONF-800616—8) **Modeling and evaluation of designs for solid hydrogen storage beds.** Fisher, P.W.; Watson, J.S. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 11p. NTIS, PC A02/MF A01.

From 3. world hydrogen energy conference; Tokyo, Japan (23 Jun 1980).

Mathematical models have been developed to predict the performance of metal-hydride beds used for hydrogen storage. The relative importance of heat transfer, mass transfer, chemical kinetics, and equilibrium has been evaluated through comparison of the models with experimental data supplied by Brookhaven National Laboratory for a cylindrical bed containing FeTi alloy. An equilibrium model containing no empirical parameters produces bed pressure and temperatures which show good agreement with experimental data; however, events like maximum pressure and centerline temperatures are predicted at times different from those observed. This model is used to evaluate two proposed designs for solid hydrogen storage beds in which (1) FeTi alloy is contained in tubes that are externally cooled, and (2) FeTi alloy is contained in a bed that is penetrated by cooling tubes. The model predicts that heat transfer surface area is utilized most effectively with the second cooling configuration.

27052 (SAN—1167-1) **Automotive storage of hydrogen using modified magnesium hydrides. Final report, March 1976-March 1978.** Rohy, D.A.; Nachman, J.F.; Hammer, A.N.; Duffy, T.E. (Solar Turbines International, San Diego, CA (USA)). 1979. Contract EY-76-C-03-1167. 82p. NTIS, PC A05/MF A01.

Metal hydrides can store more hydrogen per unit volume than normal high pressure or cryogenic techniques. Little energy is required to store the hydrogen in the hydride, and high stability at room temperature ensures low losses over long storage periods. Safety features of metal hydride storage are favorable. Because of its low weight and high hydrogen storage densities, modified magnesium hydride offers the greatest potential for automotive storage of hydrogen. Experimental and analytical work in this program has been directed toward the optimization of this storage system. Due to the relative stability of MgH_2, modifications of the MgMH/sub x/ (M = metal ion) have been made to decrease the dissociation temperature while retaining high hydrogen capacity. This parameter is crucial since vehicle exhaust will supply the thermal energy to dissociate the hydride in an automobile. System studies indicate that hydride dissociation temperature (T/sub D/) should be 200°C to ensure uninterrupted fuel flow at all driving and idle conditions. From experimental data developed in this four task study, we conclude that alloys comprised of Mg, Cu and Ni have come closest to meeting the dissociation temperature goal. Small additions of rare-earth elements to the basic alloy also contribute to a reduction of T/sub D/. The best alloy developed in this program exhibits a T/sub D/ = 223°C and a hydrogen capacity near four weight percent compared to a theoretical 7.65 percent for MgH_2. That alloy has been characterized for dissociation temperature, hydrogen capacity, kinetics, and P-C-T relationships. Dissociation temperature, hydrogen capacity and material cost are reported for each alloy tested in this program.

TRANSPORT

27053 (ORO—5598-T1) **Assessment of hydrogen compressor technology for energy storage and transmission systems. Final report.** Phadke, L.G.; Veziroglu, T.N.; Foster, R.W.; Escher, W.J.D. (Miami Univ., Coral Gables, FL (USA). Clean Energy Research Inst.; Escher Technology Associates, St. Johns, MI (USA)). Jan 1979. Contract EC-77-S-05-5598. 192p. NTIS, PC A09/MF A01.

An initial assessment of hydrogen compressor technology for prospective energy systems applications is documented. Hydrogen, and hydrogen/natural gas blends, are generally related to the existing state-of-the-art in natural gas compressors. Visits to natural gas transmission and storage facilities are reported on from the compressor-applications standpoint. Present applications of hydrogen compressors, as reported by both manufacturers and users are summarized. Theoretical fluid-dynamic and thermodynamic analysis of these fuel gases in compressors is provided. The implications of materials problems considered relevant to compressors are breifly discussed. Some general observations and recommendations from the assessment are presented.

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 27049, 27052, 27447

OTHER SYNTHETIC AND NATURAL FUELS

OTHER SYNTHETIC AND NATURAL FUELS

PROPERTIES

REFER ALSO TO CITATION(S) 26830, 26832, 27563

PREPARATION

CHEMICAL SYNTHESIS

27054 (FE—3296-1) **Gasification of residual oil in molten phosphates.** Gavalas, G.R. (California Inst. of Tech., Pasadena (USA)). Feb 1979. Contract ET-78-G-01-3296. 20p. NTIS, PC A02/MF A01.

The work performed during this period includes: (1) equipment design; (2) equipment procurement and construction; and (3) exploratory engineering studies. Following an overall system design, detailed designs were developed for the steam-generating section and the reactor assembly. Equipment purchasing has included a large electrical custom-made furnace for housing the reactor assembly and various components for the steam generator. In addition, an Inconel reactor housing with special fittings has been ordered and will be delivered soon. Engineering studies included the testing of several prototype alumina reactors and a few kinetic studies of steam-carbon reaction. The most critical phase was the construction of a reactor consisting of fused and cast alumina sections with several internal nozzles for the introduction of the reactants. Several alternative designs were tested and a satisfactory prototype has been produced. This will be soon integrated into the overall reactor assembly.

27055 **Conversion of synthesis gas to aromatic hydrocarbons.** Chang, C.D.; Lang, W.H. (to Mobil Oil Corp.). US Patent 4,180,516. 25 Dec 1979. Filed date 18 Aug 1977. 14p.

Synthesis gas is converted to aromatic hydrocarbons over an intimate mixture of catalysts containing a first component of ZnO-Cr_2O_3 and a second component selected from a selective class of acidic crystalline aluminosilicates. The mixed catalyst is characterized by catalytic activity for reduction of CO by H_2. The Zn:Cr ratio in the catalyst is less than about 4:1, the silica:alumina ratio is greater than 12:1, and the pore dimension of the catalyst is greater than about 5A.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 26771, 27101, 27102, 27103, 27104, 27107, 27109, 27112, 27113

27056 (PNL—3353) **Oxygen/steam gasification of wood.** Mudge, L.K.; Ham, D.G.; Weber, S.L.; Mitchell, D.H. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract EY-76-C-06-1830. 23p. NTIS, PC A02/MF A01.

Yields from fixed-bed gasification of stoker fuel, pressed planar shavings, are presented for air/steam operation and oxygen/steam operation at four different compositions. The wood carbon distributes between gas products and liquid products in the respective ranges of 75 to 80 wt% and 20 to 25 wt%. The cold gas efficiencies, defined as the combustible energy in the gas divided by the heat of combustion of the wood, were 60% for operation with an air-to-steam weight ratio of 10, 52%, 61%, 59%, and 52% for operation with oxygen-to-steam weight ratios of 1/2, 1, 2, and 4 respectively. The other energy inputs to the system are less than the energy output in tar products so that the above efficiencies are about the same as the overall efficiencies. Concentrations of the gas at various heights in the fixed bed are presented. Conclusions about the height of the various zones can be inferred. Temperature profiles are also prescnted. Stoker fuel was used instead of wood chips because its bulk density was greater by a factor of 4. Limitations on the maximum volumetric input rate were such that only 50 lb/hr of wood chips could be added. Since gasification rates exceeded this amount, stoker fuel was used. Rates for stoker fuel gasification are presented for the different conditions. The results indicate that the maximum weight fraction of methanol from dry wood is 0.45 at an oxygen-to-steam weight ratio of 1 with reforming of the methane in the product gas, or a yield of 135 gallons of methanol per ton of dry wood. The maximum methane yield is obtained at the same oxygen-to-steam weight ratio of 1 and is 8600 scf/dry ton (270 NM^3/dry MT).

27057 **Methanogenic decomposition of ferulic acid, a model lignin derivative.** Healy, J.B. Jr.; Young, L.Y.; Reinhard, M. (Stanford Univ., CA). *Appl. Environ. Microbiol.;* **39**: No. 2, 436-444(Feb 1980).

Ferulic acid, a model lignin derivative, was observed to be biodegradable to methane and carbon dioxide under strict anaerobic conditions. This conversion appears to be carried out by a consortium of bacteria similar to that previously described for the methanogenic degradation of benzoic acid. A temporary buildup of acetate in these cultures indicates that it is a likely intermediate and precursor for methane formation. An analog of coenzyme M, 2-bromoethanesulfonic acid (BESA), inhibited gas production and enhanced the buildup of propionate, butyrate, isobutyrate, and isovalerate. Phenylacetate, cinnamate, 3-phenylpropionate, benzoate, cyclohexane carboxylate, adipate, and pimelate were also detected in BESA-inhibited cultures. A pathway is proposed which includes these various acids as possible intermediates in the methanogenic degradation of ferulic acid. This model overlaps previously described benzoic acid degradation pathways, suggesting that this type of anaerobic degradation may be common for aromatic compounds.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 27430, 27431, 27448

PROPERTIES

REFER ALSO TO CITATION(S) 27108, 27433, 27434

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 27100, 27107, 27108, 27110, 27111, 27112, 27113

HYDRO ENERGY

HYDRO ENERGY

REGULATIONS AND LICENSING

27058 **Low head hydroelectric power in New England: the Black River project.** Berger, G.J. *Sol. Law Rep.;* **1**: No. 3, 567-582(Sep 1979).

The town of Springfield, Vermont, decided to revive its hydropower resource in 1975. Its plan called for the renovation of existing small dams and construction of others. Four years later, it is in the midst of creating a municipal utility, acquiring by condemnation utility company lines in the town, and doing further studies for its FERC license application. After spending $1.5 million, Springfield is still years away from generating its own power. This case study illustrates the problems facing a city trying to use water power to generate electricity. Pending changes in FERC licensing procedures will alleviate some of the problems Springfield has encountered, but others remain.

ECONOMICS AND MANAGEMENT

REFER ALSO TO CITATION(S) 27058

27059 (CONF-7905154—, pp 32-39) **Planning for the interface of hydropower expansion and water resources management in New England.** Klock, T.E. 8 May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

The water use planning and policy development aspects of low-head hydroelectric power commercialization in the New England region and, particularly, choosing between competing water uses, are discussed. The use of computers to rank the relative economic feasibility of about 1750 dam sites in the region potential power producers and other coordinated procedures are described. (LCL)

27060 (DOE/ID/01570—1, pp 4-7) **Pelton Reregulating Dam on the Deschutes River, Warm Springs, Oregon.** Dibble, E.F. May 1979.

From Small/low-head hydropower PRDA-1706 contractor's symposium; Albany, NY, USA (8 May 1979).

Plans for building a low-head (average operating head of 36 ft.) hydroelectric power plant at an existing dam near Madras in Central Oregon are described. This plant has been evaluated for overall cost and environmental impact. (LCL)

SOLAR ENERGY

REFER ALSO TO CITATION(S) 27289

27061 **Role of the Solar Energy Resarch Institute.** Connolly, J.S.; Grosskreutz, J.C. (Solar Energy Research Institute, Golden, CO). pp 395-403 of Solar energy: chemical conversion and storage. Hautala, R.R.; King, R.B.; Kutal, C. (eds.). Clifton, NJ; Humana Press, Inc. (1979).

From Southeastern meeting of the American Chemical Society; Savannah, GA, USA (8 Nov 1978).

The organization, facilities, and mission of the Solar Energy Research Institute is described. (WHK)

RESOURCES AND AVAILABILITY

27062 (LBL—10802) **Spectral character of solar and circumsolar radiation.** Evans, D.B.; Grether, D.F.; Hunt, A.J.; Wahlig, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 6p. (CONF-800604—25). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

An ongoing program is being conducted to provide information on the solar and circumsolar radiation (the solar aureole) for application to concentrating solar energy systems. Four instrument systems are used to obtain detailed measurements of the solar and circumsolar intensity, both as a function of angular distance from the center of the sun, and as a function of wavelength. A method of inverting filtered measurements to obtain the energy contained within a given wavelength interval is presented. Comparisons are made between the atmospheric transmission code LOWTRAN and normal incidence data. The amount of circumsolar radiation and the dependence of circumsolar radiation on angular distance from the sun are discussed as a function of wavelength for selected atmospheric conditions.

ECONOMICS

REFER ALSO TO CITATION(S) 27189

27063 **Energy impacts of solar heating.** Whipple, C. (Electric Power Research Inst., Palo Alto, CA). *Science;* **208**: 262-266(18 Apr 1980).

The energy required to build and install solar space- and water-heating equipment is compared to the energy it saves under two solar growth paths corresponding to high and low rates of implementation projected by the Domestic Policy Review of Solar Energy. For the rapid growth case, the cumulative energy invested o the year 2000 is calculated to be 1/2 to 1 1/2 times the amount saved. An impact of rapid solar heating implementation is to shift energy demand from premium heating fuels (natural gas and oil) to coal and nuclear power use in the industries that provide materials for solar equipment.

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 28002

27064 **Solar energy use and litigation in ancient times.** Jordan, B.; Perlin, J. *Sol. Law Rep.;* **1**: No. 3, 583-594(Sep 1979).

Solar energy use in ancient Greece and Rome is described. Particularly, evidence for the incorporation of passive solar design into private and public buildings is reviewed. Solar access laws as established in the Digest of Justinian are discussed. (SPH)

SOLAR ENERGY CONVERSION

27065 **Chlorophyll a water splitting light reaction.** Galloway, L.; Fruge, D.R.; Fetterman, L.M.; Fong, F.K. (Purdue Univ., West Lafayette, IN). pp 51-81 of Solar energy: chemical conversion and storage. Hautala, R.R.; King, R.B.; Kutal, C. (eds.). Clifton, NJ; Humana Press, Inc. (1979).

From Southeastern meeting of the American Chemical Society; Savannah, GA, USA (8 Nov 1978).

The finding that water-saturated chlorophyll photocatalyzes the decomposition of water is reviewed. The finding that the absence of the Mg atom in pheophytin a obliterates the capability of Chl a to catalyze water photolysis is described. In contrast with the water splitting reaction of (Chl a.2H_2O)/sub n/, no significant amounts of molecular hydrogen were detected in the photoreaction of polycrystalline Pheo a with water, which indicates that the pheophytin is reduced by the water oxidation process. The Chl a water splitting reaction is assisted by the presence of Pt, which presumably catalyzes the H_2 and O_2 evolution processes. The properties of Pt-H_2O reactions are therefore of interest in the delineation of properties exclusively attributable to the water photolysis reaction of (Chl a.2H_2O)/sub n/. We report the observation of hydrogen evoiation when Pt and water, in the absence of the chlorophyll, were heated at relatively low temperatures in the range 130 to 210°C. In sharp contrast with the water photolysis results obtained on illuminating platinized Chl a, no significant amounts of oxygen were detected in the thermochemical Pt-H_2O reaction. No molecular hydrogen and oxygen were detected when Pt in water was illuminatd in the visible wavelength region.

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 27114, 27164

27066 (COO—0039-1) **Emerging materials for solar cell applications. First quarter report, February 15-May 31, 1979.** Rod, R.L.; Shkedi, Z.; Bunshah, R.; Stafsudd, O. (Monosolar, Inc., Santa Monica, CA (USA)). 15 Jun 1979. Contract ET-78-D-04-0039. 40p. NTIS, PC A03/MF A01.

Work to develop the theory controlling the electroplating of a compound semiconductor on a transparent, conductive substrate and to demonstrate operative solar cells using the approach is reported. The current program is divided essentially into three paralleled team efforts. The first effort centers on refining the electroplating process at Monosolar so thicker and more uniform layers of p- or n-type cadmium telluride can be plated on both In_2O_3:Sn- and Ni- coated substrates. 1 μM thick polycrystalline films have been achieved for the first time ever without peeling problems, a thickness optimum for maximum solar absorption and economy of materials. Second, work is underway at UCLA to physically and electrically characterize the films and diodes made from them. Under proper conditions Schottky diodes with better than 10^4 rectification ratios at 1.5 V were obtained along with preliminary indications of grain sizes up to 1 μM. Measurements of these diodes revealed the presence of deep trapping level(s) that may be associated with plating process impurities that since may have been eliminated. Third, work so far on developing improved techniques for depositing ITO has been successful at UCLA in their effort to eliminate persistent problems with ITO obtained from outside suppliers serving the less demanding liquid crystal display (LCD) industry.

27067 (DOE/ET/20279—93) **Analytical prediction of the performance of an air photovoltaic/thermal flat-plate collector.** Raghuraman, P. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 30 Apr 1980. Contract AC02-76ET20279. 20p. NTIS, PC A02/MF A01.

A one-dimensional analysis developed by MIT Lincoln Laboratory predicts the electrical and thermal performance of an air photovoltaic/thermal flat-plate collector. The analysis compares well with test measurements, predicting the thermal efficiency to within 2 percent. From the analysis, the poor thermal performance of the collector is attributable, in part, to the large undulations of the cell/silicone pottant surface in contact with the flowing air that

results in less effective convective heat-transfer areas between the cell and the air.

27068 (DOE/ET/21074—4) **Amorphous thin films for solar-cell applications. Final report, September 11, 1978-September 10, 1979.** Carlson, D.E.; Balberg, I.; Crandall, R.S.; Goldstein, B.C.; Hanak, J.J.; Pankove, J.I.; Staebler, D.L.; Weakliem, H.A.; Williams, R. (RCA Labs., Princeton, NJ (USA)). Feb 1980. Contract AC03-78ET21074. 176p. NTIS, PC A09/MF A01.

In Section II, Theoretical Modeling, theories for the capture of electrons by deep centers in hydrogenated amorphous silicon (a-Si:H) and for field-dependent quantum efficiency in a-Si:H are presented. In Section III, Deposition and Doping Studies, the optimization of phosphorus-doped a-Si:H carried out in four different discharge systems is described. Some details of the dc proximity and rf magnetron discharge systems are also provided. Preliminary mass spectroscopy studies of the rf magnetron discharge in both SiH_4 and SiF_4 are presented. In Section IV, Experimental Methods for Characterizing a-Si:H, recent work involving photoluminescence of fluorine-doped a-Si:H, photoconductivity spectra, the photoelectromagnetic effect, the photo-Hall effect and tunneling into a-Si:H is presented. Also, studies of the growth mechanism of Pt adsorbed on both crystalline Si and a-Si:H are described. Measurements of the surface photovoltage have been used to estimate the distribution of surface states of phosphorus-doped and undoped a-Si:H. Section V, Formation of Solar-Cell Structures, contains information on stacked or multiple-junction a-Si:H solar cells. In Section VI, Theoretical and Experimental Evaluation of Solar-Cell Parameters, an upper limit of $\cong$ 400 A is established for the hole diffusion length in undoped a-Si:H. A detailed description of carrier generation, recombination and transport in a-Si:H solar cells is given. Finally, some characteristics of Pd-Schottky-barrier cells are described for different processing histories.

27069 (DOE/ET/23006—3) **[Investigation of low-cost solar cells based on Cu_2O]. Third quarterly progress report, November 1, 1979-January 31, 1980.** Olsen, L.C. (Joint Center for Graduate Study, Richland, WA (USA)). 12 Mar 1980. Contract AC04-79ET23006. 33p. NTIS, PC A03/MF A01.

Efforts this quarter concentrated on completion and checkout of the MBE system, deposition of ZnS films, analysis of the internal photoresponse for Cu-Cu_2O cells, and fabrication and characterization of Cu-Cu_2O solar cells. In-doped ZnS films with very good optical quality and finite conductivity were obtained by co-depositing In and ZnS. Analysis of the internal photoresponse indicated that minority carrier diffusion lengths on the order of 10 μm are being achieved with the present Cu_2O growth procedure. Active area values of J/sub PH/ = 8.52 mA/cm^2 and AM1 Efficiency = 1.76% were achieved for Cu-Cu_2O cells. These devices appear to have an MIS structure, or fixed charge at the interface. In particular, analysis of I-V data indicates that the current-voltage characteristics for applied voltages greater than 0.3 V are characterized by $n \cong 1$ and $J_o \cong 2 \times 10^{-9}$ mA/cm^2, which implies an effective barrier height of 0.94 eV compared to the theoretical value of 0.7 eV for a Cu/Cu_2O Schottky barrier. Another very significant achievement this past quarter was the development of a surface preparation procedure which results in a nearly perfect stochiometry at the surface.

27070 (DOE/ET/23007—1) **$CdSiAs_2$ thin films for solar cell applications. First quarter report April 9, 1979-June 30, 1979.** Burton, L.C.; Slack, L.H. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). 25 Jul 1979. Contract AC04-79ET23007. 51p. NTIS, PC A04/MF A01.

Near stoichiometric bulk polycrystalline $CdSiAs_2$ has been synthesized by two techniques: (1) direct fusion of the elements and (2) direct fusion of the binaries SiAs, Cd_3As_2 and $CdAs_2$. The latter technique resulted in denser ternary material with good homogeneity. The above binaries melt congruently and were also formed by direct fusion. Sputtered ternary films were formed using a bulk $CdSiAs_2$ target, and a composite target of $CdAs_2$ discs in a Si plate. Composition of the $CdSiAs_2$ target changed with sputtering time. Amorphous films deposited from that target were heat treated, and became crystalline and near stoichiometric but with poor mechanical properties. It appears that films deposited from the composite target (Si + $CdAs_2$) can be adjusted to stoichiometry by means of sputtering power and target geometry. As deposited, these films also were amorphous. With respect to evaporated films, the study of thermal decomposition of $CdSiAs_2$ in vacuum was completed. The decomposition is preferential toward Cd between 570° and 710°C, and toward As in the 710 to 1010°C range. It is concluded that evaporation of the ternary is not a suitable method for forming $CdSiAs_2$ films. Plans for the next reporting period include continued sputtering studies with the composite target, constructing a two-source setup for evaporated films, expanded film characterization and fabrication of bulk $CdSiAs_2$/CdS solar cells.

27071 (DOE/ET/23044—4) **Deposition, fabrication and analysis of polycrystalline silicon MIS solar cells. Final Report, January 1-December 31, 1979.** Anderson, W.A. (State Univ. of New York, Buffalo (USA). Dept. of Electrical Engineering). Mar 1980. Contract AC03-79ET23044. 112p. NTIS, PC A06/MF A01.

Discussion of MIS cell fabrication techniques, protovoltaic response data, I-V-T analysis to reveal conduction mechanisms, a detailed computer model, optimum MIS solar cell design, surface state effects, Auger studies, reliability studies and e-beam deposition of thin silicon films are included. The most important features of the work during 1979 include the one pump-down fabrication process, establishing a consistent fabrication sequence, achieving 13% efficiency of 2 cm^2 area, an evaluation of conduction mechanisms, establishing a detailed computer model and setting up an improved e-beam system to deposit thin silicon films. Details are reported. (WHK)

27072 (DOE/JPL—1012-37) **Cost of Czochralski wafers as a function of diameter.** Leipold, M.H.; Radics, C.; Kachare, A. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Feb 1980. Contract AI01-76ET20356. 19p. NTIS, PC A02/MF A01.

The impact of diameter in the range of 10 to 15 cm on the cost of wafers sliced from Czochralski ingots is analyzed. Increasing silicon waste and decreasing ingot cost with increasing ingot size are estimated along with projected costs. Results indicate a small but continuous decrease in sheet cost with increasing ingot size in this size range. Sheet costs including silicon are projected to be $50 to $60/m^2 (1980 $) depending upon technique used.

27073 (DOE/JPL/954334—79/14) **Low cost solar array project. Quarterly progress report, January-March 1980.** (Union Carbide Corp., Tonawanda, NY (USA). Linde Div.). 1980. Contract NAS-7-1P0-954334. 111p. NTIS, PC A06/MF A01.

The overall objective of the LSA Silicon Material Task is to establish a chemical process for producing silicon at a rate and rice commensurate with the production goals of the LSA project for solar-cell modules. As part of — overall Silicon Material Task, Union Carbide developed the silane-silicon process and advanced the technology to the point where it has a definite potential for providing high-purity polysilicon on a commercial scale at a price of $14/kg by 1986 (1980 dollars). This work, completed under Phases I and II of the contract, provided a firm base for the Phase III program (initiated in April 1979) aimed at establishing the practicality of the process by pursuing the following specific objectives: (1) design, fabricate, install, and operate an Experimental Process System Development Unit (EPSDU) sized for 100 MT/Yr to obtain extensive performance data to establish the data base for the design of commercial facilities; (2) perform support research and development to provide an information base usable for the EPSDU and for technological design and economic analysis for potential scale-up of the process; and (3) perform iterative economic analyses of the estimated product cost for the production of semiconductor-grade silicon in a facility capably of producing 1000 MT/Yr. Progress is repoted in detail. (WHK)

27074 (DOE/JPL/954356—79/11) **Silicon-on ceramic process. Silicon sheet growth and device developmentt for the Large-Area Silicon Sheet Task of the Low-Cost Solar Array Project. Quarterly report No. 13, October 1-December 31, 1979.** Chapman, P.W.; Zook, J.D.; Grung, B.L.; McHenry, K.; Schuldt, S.B. (Honeywell Corporate Material Sciences Center, Bloomington, MN (USA)). 15 Feb 1980. Contract NAS-7-100-954356. 72p. NTIS, PC A04/MF A01.

Research on the technical and economic feasibility of producing solar-cell-quality sheet silicon by coating inexpensive ceramic substrates with a thin layer of polycrystalline silicon is reported. The coating methods to be developed are directed toward a minimum-cost process for producing solar cells with a terrestrial conversion efficiency of 11 percent or greater. By applying a graphite coating to one face of a ceramic substrate, molten silicon can be caused to wet only that graphite-coated face and produce uniform thin layers of large-grain polycrystalline silicon; thus, only a minimal quantity of silicon is consumed. A variety of ceramic materials have been dip coated with silicon. The investigation has shown that mullite substrates containing an excess of SiO_2 best match the thermal expansion coefficient of silicon and hence produce the best SOC layers. With such substrates, smooth and uniform silicon layers 25 cm^2 in area have been achieved with single-crystal grains as large as 4 mm in width and several cm in length. Crystal length is limited by the length of the substrate. The thickness of the coating and the size of the crystalline grains are controlled by the temperature of the melt and the rate at which the substrate is withdrawn from the melt. The solar-cell potential of this SOC sheet silicon is promising. To date, solar cells with areas from 1 to 10 cm^2 have been fabricated from material with an as-grown surface. Conversion efficiencies of about 10 percent with antireflection (AR) coating have been achieved. Such cells typically have open-circuit voltage and short-circuit current densities of 0.55V and 23 mA/cm^2, respectively.

27075 (DOE/JPL/954373—80/15) **Silicon ingot casting: heat exchanger method multi-wire slicing, fixed abrasive slicing technique. Phase IV. Silicon sheet growth development for the large area sheet task of the Low-Cost Solar Array Project. Quarterly progress report**

No. l, December 15, 1979-March 31, 1980. Schmid, F.; Khattak, C.P. (Crystal Systems, Inc., Salem, MA (USA)). May 1980. Contract NAS-7--100-954373. 48p. NTIS, PC A03/MF A01.

Ingots have been solidified in molded crucibles which have rounded corners to produce squarish shaped ingots. Rigid retainers used to support the crucibles at high temperatures have improved the shape of the ingot by flattening of the sides; however, the corners are still rounded. Crucibles fabricated by welding flat plates into a box shape have produced ingots with sharp corners. Flat graphite plates supported and extended above the crucible hold meltstock prior to melting. The use of flat plates and rigid retainers has produced 17 cm cube ingots. The combination of flat plates and shorter crucibles will have a significant impact on the cost of the crucible and will result in squarer ingots to improve the yields. In-house characterization of HEM solidified UMG silicon has demonstrated 12.33% solar cells. In preparation for scale-up, the new furnace designed for casting 30 cm cube ingots has shown very good performance. Impregnation of diamonds in the cutting edge only is beneficial to reduce kerf and costs, and improve accuracy. Fabrication of wirepacks is a multi-parameter problem with interactive variables. Variables relating to introduction of diamond into the die appear critical; therefore, variables such as copper sheath thickness that do not relate to this have been fixed. Improvement has been made in impregnating the wirepacks to effectively slice the first ingot.

27076 (DOE/JPL/954521—80/12) **Integral glass encapsulation for solar arrays. Quarterly progress Report No. 12, October 11, 1979-January 10, 1980.** Young, P.R. (Spire Corp., Bedford, MA (USA)). Feb 1980. Contract NAS-7-100-954521. 25p. NTIS, PC A02/MF A01.

This is the twelfth quarterly report under a JPL/DOE program for the development of electrostatic bonding as a method of integral encapsulation of solar cells in glass. Efforts for the current phase of this program are to continue to demonstrate process uniformity of electrostatic bonding encapsulation. Additional goals of this program are to develop preformed (wire mesh) contacts as a method of integrating cell processing into the encapsulation procedure resulting in a low cost module assembly technique, and to investigate low-temperature bonding to commercially available glass (pyrex) substrates. Progress is reported.

27077 (DOE/JPL/954521—80/13) **Integral glass encapsulation for solar arrays. Quarterly progress report No. 13.** Landis, G.A. (Spire Corp., Bedford, MA (USA)). Mar 1980. Contract NAS-7-100-954521. 23p. NTIS, PC A02/MF A01.

Progress on the development of electrostatic bonding as a method of integrally encapsulating silicon solar cells in glass is reported. Efforts for the current phase of this program are to continue to demonstrate process uniformity of encapsulation by electrostatic bonding. An additional goal for this program is to develop preformed contacts as a method of integrating cell processing into the encapsulation procedure, resulting in a low-cost module assembly technique.

27078 (DOE/JPL/954698—78/1) **Study of curved glass photovoltaic module and module electrical isolation design requirements. Final report.** (Bechtel National, Inc., San Francisco, CA (USA)). Jun 1980. Contract NAS-7-100-954698. 187p. NTIS, PC A09/MF A01.

Bechtel National, Inc., has conducted a study to evaluate the technical feasibility and cost effectiveness of curved glass superstrate photovoltaic modules for use in large scale applications such as central station power plants. The study also evaluated electrical insulation and isolation design considerations with regard to module encapsulation systems. The design of a 1.2 by 2.4 m (4 by 8 ft) curved glass superstrate and support clip assembly is presented, along with the results of finite element computer analyses and a glass industry survey conducted to assess the technical and economic feasibility of the concept. Installed costs for four curved glass module array configurations are estimated and compared with costs previously reported for comparable flat glass module configurations. Electrical properties of candidate module encapsulation systems are evaluated along with present industry practice for the design and testing of electrical insulation systems. Electrical design requirements for module encapsulation systems are also discussed.

27079 (DOE/JPL/955269—79/2) **Low cost solar array project. Task I. Silicon material. Gaseous melt replenishment system. Second quarterly progress report, July 18-October 17, 1979.** Jewett, D.N.; Bates, H.E.; Hill, D.M. (Energy Materials Corp., Harvard, MA (USA)). 1979. Contract NAS-7-100-955269. 14p. NTIS, PC A02/MF A01.

Progress on the design, production, and testing of a prototype chemical reactor for silicon production is described. During the second quarterly reporting period design activities continued on a number of components of the reactor furnace system and heat exchangers. Numbers of purchased components have been received, mainly for the gas handling system. Assembly of the gas handling system is under way.

27080 (DOE/JPL/955270—79/3) **Low cost Czochralski crystal growing technology: near term implementation of the flat plate photovoltaic cost reduction of the low cost solar array project. Third quarterly progress report, October 1-December 31, 1979.** Roberts, E.G. (Kayex Corp., Rochester, NY (USA)). 1979. Contract NAS-7-100-955270. 30p. NTIS, PC A03/MF A01.

The purpose of the program is to demonstrate the growth of up to 150 kilograms of 6" diameter single crystal silicon ingot from one crucible by the Czochralski (CZ) method. The method being developed relies upon conventional CZ technology combined with new equipment and process designs and concepts. These concepts alternate cycles of crystal growth and hot melt replenishment and are designed to oe ultimately suitable for use in a high volume production facility. A Hamco Model CG2000 RC crystal grower will be utilized for the project. Modifications will be comprehended into the puller which will allow a special chamber to be fitted. This chamber will allow for the storage of polycrystalline silicon rod to be used in the accelerated melt and crucible recharge cycle. A vacuum tight isolation valve will be incorporated into the system to allow retrieval of grown crystals and crucible melt replenishment without contamination. Progress is reported.

27081 (DOE/JPL/955270—80/1) **Low cost Czochralski crystal growing technology: near term implementation of the flat plate photovoltaic cost reduction of the Low Cost Solar Array Project. Fourth quarterly progress report, January 1-March 31, 1980.** Roberts, E.G. (Kayex Corp., Rochester, NY (USA)). 1980. Contract NAS-7-100-955270. 31p. NTIS, PC A03/MF A01.

The purpose of the program is to demonstrate the growth of up to 150 kilograms of 6" diameter single crystal silicon ingot from one crucible by the Czochralski (CZ) method. The method being developed relies upon conventional CZ technology combined with new equipment and process designs and concepts. These concepts alternate cycles of crystal growth and hot melt replenishment and are designed to be ultimately suitable for use in a high volume production facility. A Hamco Model CG2000 RC crystal grower will be utilized for the project. Modifications will be comprehended into the puller which will allow a special chamber to be fitted. This chamber will allow for the storage of polycrystalline silicon rod to be used in the accelerated melt and crucible recharge cycle. A vacuum tight isolation valve will be incorporated into the system to allow retrieval of grown crystals and crucible melt replenishment without contamination. Additional modifications designed into the system allow for accelerated methods of melting both polycrystalline silicon rods and polycrystalline silicon chunks by the use of R.F. induction heating. Progress is reported. (WHK)

27082 (DOE/JPL/955281—80/06) **Use of glass reinforced concrete (GRC) as a substrate for photovoltaic modules. Final report.** Eirls, J.L. (MB Associates, San Ramon, CA (USA)). 12 Mar 1980. Contract NAS-7-100-955281. 112p. NTIS, PC A06/MF A01.

MB Associates (MBA), under contract to Jet Propulsion Laboratories (JPL) developed a substrate for flat plate photovoltaic solar panel arrays using a glass fiber reinforced concrete (GRC) material. The installed cost of this GRC panel (designed, developed and fabricated by MBA) is 30% less than the JPL cost goal of the Near Term Low-Cost Flat Plate Photovoltaic Solar Array Program. The 4' x 8' panel is fabricated from readily available inexpensive materials, weighs a nominal 190 lbs., has exceptionally good strength and durability properties (rigid and resists weathering), is amenable to mass production and is easily installed on simple mountings. Solar cells are encapsulated in ethylene/vinyl acetate (EVA) with Tedlar backing and Korad cover film. The laminates are attached to the GRC substrate with acrylic transfer tape and edge sealed with a silicone RTV adhesive.

27083 (DOE/JPL/955282—79/4) **LSA large area silicon sheet task enhanced I.D. slicing. Quarterly report No. 4, October-December 1979.** Walters, D. (Siltec Corp., Menlo Park, CA (USA)). Jan 1980. Contract NAS-7-100-955282. 26p. NTIS, PC A03/MF A01.

The purpose of this program is to develop and demonstrate enhanced I.D. slicing technology that will significantly increase the number of usable slices per inch of ingot over industry practice. This process requires a reduction in both blade and slice thickness and will be achieved through a combination of three key slicing technology elements: ingot rotation with minimum exposed blade area, dynamic cutting edge control, and the use of prefabricated insert blades. Demonstration runs continued this quarter on schedule. Most runs incorporated the method of ingot rotation in an attempt to reduce kerf loss to between 130 and 180 microns while achieving slice thickness of less than 254 microns. The method of bidirectional slicing as an alternative approach to more efficient wafer sicing was also successfully demonstrated. A great deal of energy was spent in an effort to increase productivity through programmed ingot feed rates. In addition, experiments utilizing coolant flow in order to improve cutting action were performed, including incluence on the wafer surface. A cutting edge position control mechanism was manufactured late in the quarter. An alternative blade construction requiring special etching techniques was further explored which

produces kerf of 152 microns. A characerization of slices produced with ingot rotation was performed.

27084 (DOE/JPL/955282—80/5) **LSA large area silicon sheet task enhanced I.D. slicing. Quarterly report No. 5, January-March 1980.** Walters, D. (Siltec Corp., Menlo Park, CA (USA)). Apr 1980. Contract NAS-7-100-955282. 27p. NTIS, PC A03/MF A01.

This program is intended to develop and demonstrate enhanced I.D. slicing technology that will significantly increase the number of usable slices per inch of ingot over industry practice. This process requires a reduction in both blade and slice thickness and will be achieved through a combination of three key elements of slicing technology: ingot rotation with minimum exposed blade area, dynamic cutting edge control, and the use of prefabricated insert blades. Tests continued this quarter as dictated by the Program Plan. In all demonstrations, the ingots were rotated with the ultimate goal of keeping kerf loss at a minimum (between 130 to 180 microns) while achieving slice thickness of less than 250 microns. In almost all cases, ingots were 100 mm in diameter. Typical feed rates averaged 14 mm per minute. It was demonstrated that blade deflection can be effectively controlled through the use of the cutting edge position control system. This system has significantly increased wafer productivity. A blade dressing device was developed and installed thus obtaining truing precision superior to that of the hand-held dressing stick.

27085 (DOE/JPL/955318—79/3) **New method of metallization for silicon solar cells. Final report, December 1978-September 1979.** Macha, M. (SOL/LOS, Inc., Los Angeles, CA (USA)). Dec 1979. Contract NAS-7-100-955318. 67p. NTIS, PC A04/MF A01.

Research on a new metallization process based on the Mo-Sn system is described. MoO_3 is used as the source of Mo, since its relatively low melting point and ease of reduction to metallic molybdenum. The tasks performed during this study include: (1) establishing the reduction cycle for MoO_3; (2) determining the reaction mechanism for MoO_3-Sn mixture; (3) establishing the ratio of MoO_3-Sn for the ink composition; (4) formulation of screenable ink; (5) evaluation of photovoltaic cells metallized with the ink; (6) comparison of the Mo-Sn metallization with nickel plated and silk screened silver contacts; (7) environmental test of metallized cells; (8) metallization of N/P cells with BSF and comparison with cells metallized with evaporated Ti-Ag contact; and (9) cost analysis of the process. The reaction mechanism study of MoO_3 and its mixture with Sn was conducted in an experimental station consisting of a graphite strip-heater and a Pyrex belljar under close control of temperature-atmosphere-time while allowing visual observations of the reactions. The metallization of the cells was done in a diffusion tube furnace. In order to obtain a low ohmic contact to the cell, the basic ink composition was modified with a small addition of titanium in the form of titanium resinate. The electrical characteristics of the cells were comparable with the existing metallization processes. The cost analysis was based on projected production output of one MegaWatt per year, using 2"diam. Silicon crystal wafers and the current material costs. In comparison with the standard processes using silver as the contacting metal, the saving obtained by the use of this new process is a direct result of the price difference between silver and molybdenum oxide with tin.

27086 (DOE/JPL/955387—79/2) **Anti-reflection coatings applied by acid leaching process. Quarterly technical report No. 2, July 1-September 30, 1979.** Pastirik, E. (Motorola, Inc., Phoenix, AZ (USA). Semiconductor Group). 1979. Contract NAS-7-100-955387. 15p. NTIS, PC A02/MF A01.

This report covers the second third of a nine-month program to study the production of anti-reflective coatings for glass solar module covers by means of a silica-saturated fluosilicic acid etch. The efforts of the program during this second quarterly period have been to evaluate the effects of process variations on the production of coated glass samples, to test the abrasion resistance of coated samples, and to test the chemical durability of samples. Progress is reported.

27087 (DOE/JPL/955506—79-1) **Ion-plating of solar cell arrays encapsulation task, LSA Project 32. First quarterly progress report, December 1979-March Jun 1980.** Conley, W.R. (Illinois Tool Works, Inc., Elgin (USA). Venture Group). 1980. Contract NAS-7-100-955506. 22p. NTIS, PC A02/MF A01.

Ion-plating is a vacuum metallizing process where the depositant is evaporated from a source (tungsten filament, electron beam gun, etc.) into a high frequency electric field where the material is ionized and then accelerated by a DC field toward the substrate. This process combines the high deposition rates associated with physical vapor deposition and improved adhesion without entrapment of Ar gas (as in sputtering). The ITW contract was initiated in December 1979 to investigate, develop, and demonstrate the capability to produce operational solar cells having metallizations and AR coatings deposited by gasless ion-plating, which will separately and/or in combination with a low cost encapsulation system meet the LSA project life, cost and performance goals. Under this contract ITW will also investigate the ability to deposit by gasless ion-plating AR and anti-soiling coatings on glass; said coatings to be permanent and possess 20 year durability. Progress is reported.

27088 (DOE/JPL/955533—79-2) **Development of a polysilicon process based on chemical vapor deposition. Phase 1. Second quarterly progress report, January 1-March 31, 1980.** Sharp, K.; Arvidson, A.; Plahutnik, F.; Sawyer, D. (Hemlock Semiconductor Corp., MI (USA)). May 1980. Contract NAS-7-100-955533. 54p. NTIS, PC A04/MF A01.

The goal of this program is to demonstrate that a dichlorosilane-based reductive chemical vapor deposition (CVD) process is capable of producing, at low cost, high quality polycrystalline silicon. Physical form and purity of this material will be consistent with LSA material requirements for use in the manufacture of high efficiency solar cells. The feasibility of silicon generation from dichlorosilane has been well established in the preceding quarter. A number of runs have been conducted over a broad range of conditions in an experimental CVD reactor. Silicon rods of very good surface quality and up to 42 mm in diameter have been grown in predominantly dichlorosilane-fed reactor runs. Molar silicon conversion efficiencies in excess of 45% have been observed (the projected conversion was only 35%), and unprecedented values of silicon deposition rate (high) and power consumption per kg silicon produced (low) were established for the reactor. Under comparable conditions, deposition rates and conversions for dichlorosilane runs are approximately twice those for trichlorosilane runs. Of particular importance is the fact that very few reactor-related operational problems were observed during any of the dichlorosilane runs. Design of the Process Development Unit (PDU), whose function it will be to generate and purify dichlorosilane for feed to a production scale reactor, is complete, except for details of fire and spill protection. Preliminary work on the EPSDU (a 100 metric ton dichlorosilane production, purification and recovery facility) has been completed, and includes a material balance for the proposed process.

27089 (DSE—2207-T2) **Thin film polycrystalline silicon solar cells. Quarterly report No. 1, 1 October-31 December 1978.** Sarma, K.R.; Rice, M.J. (Motorola, Inc., Phoenix, AZ (USA). Solar Energy Dept.). 1978. Contract ET-78-C-03-2207. 44p. NTIS, PC A03/MF A01.

During this quarter, the Energy Beam deposition system was modified to obtain a deposition zone of uniform temperature. Parametric studies of silicon deposition are being conducted using this system employing a square cross-section reactor with $SiHCl_3$ as silicon source gas. In these experiments, large-area self-supporting silicon films with lengths up to 18" were produced. As a long term solution to beam arcing problems, a rotating energy beam nozzle was designed, built and tested. Silicon deposition experiments using SiO_2 coated molybdenum indicated that SiO_2 acts as a good diffusion barrier and prevents the formation of $MoSi_2$; these films, however, would not separate from the substrate, so it appears that an $MoSi_2$ interface is necessary for shear separation. Energy Beam deposited silicon films were grain enhanced by the RTR technique. These silicon films, as grown, have exhibited unmeasurably low (by the SPV technique) minority carrier diffusion lengths, possibly due to a pervasive contamination during RTR growth. However, a gettering sequence involving PH_3 diffusion has been found to substantially improve the diffusion length of RTR processed CVD silicon films, and similar improvements can be expected in the energy beam films also, Diffusion lengths in excess of 100 μm were observed in the gettered CVD silicon films.

27090 (DSE—4042-T10) **Photoelectronic properties of zinc phosphide crystals, films and heterojunctions. Quarterly progress report No. 1, February 26-June 30, 1979.** Bube, R.H. (Solar Energy Research Inst., Golden, CO (USA); Stanford Univ., CA (USA). Dept. of Materials Science and Engineering). Jul 1979. Contract EG-77-C-01-4042. 10p. NTIS, PC A02/MF A01.

A closed tube method has been developed for the synthesis of Zn_3P_2 from the elements which eliminates the potential dangers associated with high P pressures. Subsequent materials synthesis will be done routinely by this method. Initial efforts at single crystal growth of Zn_3P_2 from this material yielded polycrystalline material because of nucleation along the walls of the tube. Techniques for improving the situation are being tested. Wafers of large-grain polycrystaline Zn_3P_2 have been received from Dr. A. Catalano at Delaware and will be used for exploratory research in the quarter ahead. Progress is reported on the development of a CVD apparatus for the deposition of wide bandgap oxides and sulfides on a variety of substrates including Zn_3P_2. Layer deposition by the close spaced vapor transport method to be applied to Zn_3P_2 was successfully tested using CdTe on both quartz and CdS substrates.

27091 (DSE—4042-T12) **Photoelectronic properties of zinc phosphide crystals, films and heterojunctions. Quarterly progress report No. 2, July 1-September 30, 1979.** Bube, R.H. (Solar Energy Research Inst., Golden, CO (USA); Stanford Univ., CA (USA). Dept.

of Materials Science and Engineering). Oct 1979. Contract EG-77-C-01-4042. 25p. NTIS, PC A02/MF A01.

The closed tube horizontal growth method has been pursued for the growth of single crystals of Zn_3P_2. The rate of material transport was increased by increasing the temperature difference between source and growth regions and by decreasing the distance involved. A boule with only 2 grains in a 12 mm diameter has been obtained. The as-grown resistivity of this single crystal Zn_3P_2 was 50 ohm-cm, which was reduced to 10 ohm-cm by subsequent annealing in hydrogen at 410°C. Initial ZnO/Zn_3P_2 (CVD deposition of ZnO) and CdS/Zn_3P_2 (CdS by vacuum evaporation) heterostructures were fabricated using small samples of single crystal Zn_3P_2 sent from Tony Catalano at Delaware. Not surprisingly, only small photoresponse was obtained with these totally experimental cells. Zn_3P_2 films deposited on glass by CSVT were shown to be amorphous whereas those deposited on single crystal CdS were polycrystalline. Indeed several samples showed appreciable large-grain columnar growth at an angle to the substrate plane. Laser annealing was shown to have dramatic effects in crystallizing Zn_3P_2 films deposited on Si_3N_4 film substrates on sngle crystal Si. Thin films of Zn_3P_2 were deposited on glass substrates by vacuum evaporation. As-deposited film resistivities fell in the range of 10^6-10^8 ohm-cm; an apparently temporary decrease in resistivity by factors up to 50 could be obtained by annealing in hydrogen. Optical transmission and reflection spectra, as well as photoconductivity spectral response spectral response spectra were measured on a number of these films.

27092 (DSE—4042-T19) **Cadmium sulfide/copper sulfide heterojunction cell research. Quarterly technical progress report, June 1-September 30, 1979.** Thornton, J.A. (Solar Energy Research Inst., Golden, CO (USA)). 30 Nov 1979. Contract EG-77-C-01-4042. 46p. NTIS, PC A03/MF A01.

Off-stoiciometry CdS coatings with resistivities of about 10Ω-cm have been deposited by a cyclic reactive sputtering process where the H_2S injection is periodically switched on and off. Cells with CdS layer fabricated in this way have yielded efficiencies of about 0.6% with short circuit currents of about 3.5 mA/cm², open circuit voltages of about 0.43V, and fill factors of about 0.40. CdS resistivity control by In doping has been achieved both by diffusion from a pre-deposited In layer and by using an In-doped Cd sputtering target. Resistivities of about 30Ω-cm are achieved in CdS coatings about 5 um thick deposited at 250°C over 50 nm thick In layers. A Cd cathode doped with 1 atomic percent In has yielded CdS coatings with resistivities of about 0.1 Ω-cm at substrate temperatures in the 100 to 300°C range. Cells fabricated from the 0.1 Ω-cm CdS with a 0.5 um undoped layer adjacent to the junction have yielded encouraging diode characteristics with a strong photovoltaic effect and will be used to an optimization study. Cu/sub x/S coatings deposited onto CdS under various conditions have been found to have the same properties as those deposited onto glass substrates in previous studies. The amount of sputtering that is required in order to deposit the Cu_2S heterojunction layer is small compared to that requird to achieve steady state conditions in the deposition apparatus. Thus pre-conditioning is required. The results of experiments that examines various conditioning procedures are reported.

27093 (DSE—4042-T33) **Low cost silicon process development. Phase III: process optimization and evaluation. Third quarterly technical progress report.** Moore, E.; Newman, C.; Messina, L. (Schumacher (J.C.) Co., Oceanside, CA (USA)). Mar 1980. Contract EG-77-C-01-4042. 22p. NTIS, PC A02/MF A01.

The goal of the Low Cost Silicon Process Development project is to determine technical and economic feasibility of a tribromosilane-based process for the production of Solar Cell Grade Silicon. To accomplish this project goal, three principal tasks have been defined: (1) an experimental chemistry task; (2) a mini-plant design and construction task; and (3) a mini-plant operation and evaluation task. The scope of the experimental chemistry task includes optimization of the process with design verification studies at bench scale level. The mini-plant design task is focused on construction of a flexible, cost effective mini-plant. The final task is concerned with the generation of sufficient high quality process data through mini-plant operation to support an accurate assessment of the potential of the process for meeting DOE silicon material quality and cost goals. Progress is reported.

27094 (DSE—4042-T41) **Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program.** Storti, G.; Regnault, W.; Johnson, S. (Solarex Corp., Rockville, MD (USA)). 1980. Contract AC02-77CH00178. 23p. NTIS, PC A02/MF A01.

A Veeco resistance heated Czochralski crystal growing furnace was redesigned to allow for the in-situ casting of semicrystalline silicon ingots. The casting technique that is being employed in this program is based upon the Bridgeman technique of crystal growth. Samples of metallurgical grade silicon have been obtained from Ohio-Ferro Alloys corporation and preparation of this material has begun for incorporation into the experimental castings. Initial casting experiments have commenced using pure semiconductor grade silicon to establish a base line process for later experiments which will employ metallurgical grade silicon.

27095 (SAND—80-7011) **Analysis of a passive heat pipe cooled solar photovoltaic receiver.** Feldman, K.T. Jr.; Kenney, D.D. (Energy Engineering, Inc., Albuquerque, NM (USA); New Mexico Univ., Albuquerque (USA)). May 1980. Contract AC04-76DP00789. 97p. NTIS, PC A05/MF A01.

A design study to analyze the performance of an aluminum heat pipe for passive cooling of photovoltaic cells is presented. The heat pipe vessel is an aluminum extrusion with a wedge-shaped cross section. The solar cells are mounted on the lower surface where they are irradiated by a parabolic trough solar concentrator. The maximum solar cell temperature is 140°C. Heat is removed from the condenser surface by convection to the ambient air at 40°C. Working fluid selection, heat pipe analysis, and method of performance calculations are described. Results and conclusions are discussed. (WHK)

27096 (SAND—80-7018) **Silicon concentrator solar cell manufacturing development.** Grenon, L. (Motorola, Inc., Phoenix, AZ (USA). Solar Operations). May 1980. Contract AC04-76DP00789. 174p. NTIS, PC A08/MF A01.

A manufacturing development program has been conducted in which silicon concentrator solar cells designed to operate at 50 suns (AM1) were produced. The purpose of this program was to determine the various design requirements for the cell at concentration, develop the manufacturing processes necessary to fabricate the solar cell, and fabricate a total of 2000 solar cells of two separate geometries. Additionally, a detailed manufacturing cost analysis would be performed. Testing of the cells would be conducted at testing facilities located at Arizona State University and Sandia Laboratories. A technical analysis has been performed to determine those parameters that affect the performance of a silicon concentrator solar cell. For the purposes of this contract, this analysis has been limited to solar concentrations up to 50 suns. Included in the analysis are examinations of the base and emitter regions, surface effects, spectral response, and specific design criteria for both type I and type II concentrator solar cells. Based on the design requirements, a manufacturable process has been developed and cells have been fabricated.

27097 **Effects of grain boundaries in polycrystalline solar cells.** Zook, J.D. (Honeywell Technology Center, Bloomington, Minnesota 55420). *Appl. Phys. Lett.;* **37**: No. 2, 223-226(15 Jul 1980).

In polycrystalline solar cells, the short-circuit current is reduced (compared to single-crystal cells) due to recombination of minority carriers at the grain boundaries. The magnitude of this reduction is calculated for the case of a monochromatic beam of light, assuming that both the light beam and the grain boundaries are perpendicular to a p-n junction. The photoresponse of the junction is calculated in terms of the absorption coefficient of the light, the minority-carrier diffusion length, the surface recombination velocity at the grain boundary and the distance of the light beam from the grain boundary. The analysis gives an expression for an effective grain boundary width which depends on wavelength. This width determines the reduction in short-circuit current of solar cells made from material with columnar-type grains.

27098 **Laser techniques in photovoltaic applications.** Young, R.T.; Wood, R.F.; Narayan, J.; Christie, W.H. (Oak Ridge National Lab., TN). pp 36-41 of Laser applications in materials processing. Bellingham, WA; Society of Photo-Optical Instrumentation Engineers (1980).

High-power laser pulses are being used to replace conventional high-temperature furnace processing in the development of high-speed, low-cost solar cell fabrication methods. Three different approaches to p-n junction formation have been studied: (1) junction formation from laser-annealed, ion-implanted Si in which laser radiation is used to remove radiation damage and to recover the electrical activity in the implanted layer; (2) junction formation by laser-induced diffusion in which a thin film of dopant is first deposited on the substrate and then incorporated into the near-surface region by laser-induced melting of the near-surface region; and (3) laser-induced epitaxial junction formation in which a heavily doped amorphous silicon layer is deposited on a Si substrate and epitaxially regrown from the substrate layer which has been partially melted by the laser radiation. We have demonstrated that all three methods can provide suitable candidates for junction formation in high-efficiency Si solar cells. These laser techniques are particularly attractive for p-n junction formation in thin-film polycrystalline material. In conventional thermal diffusion, enhanced diffusion along grain boundaries can cause short circuits between the emitter region and the substrate. With the laser techniques, the near-surface region of the film actually melts but for such short times ($\sim 10^{-7}$ sec) that significant dopant diffusion to and along the grain boundaries does not occur, thus giving control of grain boundary diffusion and segregation.

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 27056, 27057, 27116

27099 (ANL/EES-TM—86) **Assessment of Peruvian biofuel resources and alternatives.** Harper, J.P.; Smith, W.; Mariani, E. (Argonne National Lab., IL (USA)). Aug 1979. Contract W-31-109-ENG-38. 57p. NTIS, PC A04/MF A01.

Comprehensive assessment of the biofuel potential of Peru is based on: determination of current biofuel utilization practices, evauation of Peruvian biomass productivity, identification of Peruvian agricultural and forestry resources, assessment of resource development and management concerns, identification of market considerations, description of biofuel technological options, and identification of regional biofuel technology applications. Discussion of current biofuel utilization centers on a qualitative description of the main conversion approaches currently being practiced in Peru. Biomass productivity evaluations consider the terrain and soil, and climatic conditions found in Peru. The potential energy from Peruvian agricultural and forestry resources is described quantitatively. Potental regional production of agricultural residues and forest resources that could supply energy are identified. Assessment of resource development and management concerns focuses on harvesting, reforestation, training, and environmental consequences of utilization of forest resources. Market factors assessed include: importation, internal market development, external market development, energy policy and pricing, and transportation. Nine biofuel technology options for Peru are identified: (1) small-to-medium-scale gasification, (2) a wood waste inventory, (3) stationary and mobile charcoal production systems, (4) wood distillation, (5) forest resource development and management, (6) electrical cogeneration, (7) anaerobic digestion technology, (8) development of ethanol production capabilities, and (9) agricultural strategies for fuel production. Applications of these biofuel options are identified for each of the three major regions - nine applications for the Costa Region, eight for the Sierra Region, and ten for the Selva Region.

27100 (ANL/EES-TM—88) **Alcohol production from agricultural and forestry residues.** Opilla, R.; Dale, L.; Surles, T. (Argonne National Lab., IL (USA)). May 1980. Contract W-31-109-ENG-38. 30p. NTIS, PC A03/MF A01.

A variety of carbohydrate sources can be used as raw material for the production of ethanol. Section 1 is a review of technologies available for the production of ethanol from whole corn. Particular emphasis is placed on the environmental aspects of the process, including land utilization and possible air and water pollutants. Suggestions are made for technological changes intended to improve the economics of the process as well as to reduce some of the pollution from by-product disposal. Ethanol may be derived from renewable cellulosic substances by either enzymatic or acid hydrolysis of cellulose to sugar, followed by conventional fermentation and distillation. Section 2 is a review of the use of two agricultural residues - corn stover (field stalks remaining after harvest) and straw from wheat crops - as a cellulosic feedstock. Two processes have been evaluated with regard to environmental impact - a two-stage acid process developed by G.T. Tsao of Purdue University and an enzymatic process based on the laboratory findings of C.R. Wilke of the University of California, Berkeley. Section 3 deals with the environmental residuals expected from the manufacture of methyl and ethyl alcohols from woody biomass. The methanol is produced in a gasification process, whereas ethanol is produced by hydrolysis and fermentation processes similar to those used to derive ethanol from cellulosic materials.

27101 (COO—4388-5) **Liquid fuels production from biomass. Progress report No. 5, July 1-September 30, 1978.** Sanderson, J.E.; Wise, D.L. (Dynatech R/D Co., Cambridge, MA (USA)). 1978. Contract AC02-77ET20050. 37p. NTIS, PC A03/MF A01.

The current program to convert biomass into liquid hydrocarbon fuels is an extension of the previous program to ferment marine algae to acetic acid. In that study, it was found that marine algae could be converted to higher aliphatic organic acids and that these acids could be readily removed from the fermentation both by membrane or liquid-liquid extraction. It was then proposed to convert these higher organic acids to aliphatic hydrocarbons via Kolbe Electrolysis, which may be used as a diesel fuel. The specific goals for the current program are: (1) Establish conditions under which substrates other than marine algae may be converted in good yield to organic acids. The primary task in this regard is methane suppression. (2) Modify the current 300 liter fixed packed bed batch fermenter to operate in a continuous mode. (3) Change from membrane extraction of organic acids to liquid-liquid extraction. (4) Optimize the energy balance of the electrolytic oxidation process. The primary task in this regard is to reduce the working potential required for the electrolysis while maintaining an adequate current density. (5) Scale the entire process up to match the output of the 300 liter fermenter. The accomplishments in this program are on schedule. Substantial progress has been made on the problem of methane suppression through the use of sulfide addition and the identification of bromoethane-sulfonic acid as a specific inhibitor of methanogenesis. A conceptual design of a continuously fed fixed packed bed fermenter is presented. Experimental results show that the electrolysis of organic acids produced by fermentation to liquid hydrocarbon fuels already have a favorable energy balance of 6/1 based on the applied potential and over 10/1 based on the working potential.

27102 (COO—4388-6) **Liquid fuels production from biomass. Progress report No. 6, 1 October-31 December 1978.** Sanderson, J.E.; Wise, D.L. (Dynatech R/D Co., Cambridge, MA (USA)). 1978. Contract AC02-77ET20050. 59p. NTIS, PC A04/MF A01.

The current program to convert biomass into liquid hydrocarbon fuels is an extension of the previous program to ferment marine algae to acetic acid. In that study, it was found that marine algae could be converted to higher aliphatic organic acids and that these acids could be readily removed from the fermentation both by membrane or liquid-liquid extraction. It was then proposed to convert these higher organic acids to aliphatic hydrocarbons via Kolbe Electrolysis, which may be used as a diesel fuel. The specific goals for the current program are: (1) establish conditions under which substrates other than marine algae may be converted in good yield to organic acids. The primary task in this regard is methane suppression; (2) modify the current 300 liter fixed packed bed batch fermenter to operate in a continuous mode; (3) change from membrane extraction of organic acids to liquid-liquid extraction; (4) optimize the energy balance of the electrolytic oxidation process. The primary task in this regard is to reduce the working potential required for the electrolysis while maintaining an adequate current density; and (5) scale the entire process up to match the output of the 300 liter fermenter. The accomplishments in this program are on schedule. Experimental results show that the electrolysis of organic acids produced by fermentation to liquid hydrocarbon fuels already have a favorable energy balance of 6/1 based on the applied potential and over 10/1 based on the working potential.

27103 (COO—4388-9) **Liquid fuels production from biomass. Progress report No. 8, July 1-September 30, 1979.** Sanderson, J.E.; Wise, D.L.; Levy, P.F.; Molyneaux, M.S. (Dynatech Corp., Cambridge, MA (USA)). 15 Oct 1979. Contract AC02-77ET20050. 33p. NTIS, PC A03/MF A01.

It was found that marine algae could be converted to higher aliphatic organic acids and that these acids could be readily removed from the fermentation broth by membrane or liquid-liquid extraction. It was then proposed to convert these higher organic acids to aliphatic hydrocarbons via Kolbe electrolysis, which may be used as a diesel fuel. A coenzyme M analogue, 2-bromoethanesulfonic acid has been shown to be an effective suppressor of methane in nonsterile anaerobic fermentation of cellulosic substrates. A tapered auger device has been designed and built which has been demonstrated on the bench to be effective for adding substrate and removing residue in a continuous manner from a fixed packed bed fermenter. A solvent extracter system using kerosene as the nonaqueous phase has been constructed and is currently in operation in series with the 300 liter fixed packed bed fermenter. The electrolytic oxidation of organic acids produced in the 300 liter fixed packed bed fermenter is operating with a favorable energy balance of 6/1 based on the applied potential. As stated earlier the liquid-liquid extractor system is operating in line with the 300 liter fixed packed bed fermentor. The other components of an integrated continuous system, the continuous feed device and the Kolbe electrolysis cell are operating satisfactorily out of line on a scale compatible with the 300 liter fixed packed bed fermentor. An economic analysis for a 1000 ton per day plant has been performed and has been improved and updated based on additional experimental results. Currently a cost based on utility financing including a reasonable return on investment of $5.48/million Btu is estimated, making the process fully competitive with the most favorable estimates from other processes for producing liquid fuels from renewable resources.

27104 (COO—4388-10) **Liquid fuels production from biomass. Progress report No. 10, October 1-December 31, 1979.** Sanderson, J.E.; Levy, P.F.; Wise, D.L.; Nabor, M.R.; Molyneaux, M.S.; Hughes, C.A. (Dynatech Corp., Cambridge, MA (USA)). 1 Feb 1980. Contract AC02-77ET20050. 67p. NTIS, PC A04/MF A01.

It was found that marine algae could be converted to higher aliphatic organic acids and that these acids could be readily removed from the fermentation broth by membrane or liquid-liquid extraction. It was then proposed to convert these higher organic acids via Kolbe Electrolysis to aliphatic hydrocarbons, which may be used as a diesel fuel. A coenzyme M analogue, 2-bromoethanesulfonic acid has been shown to be an effective suppressor of methane in nonsterile anaerobic fermentation of cellulosic substrates. Preliminary experiments have also been completed utilizing corn meal in which 2-bromoethanesulfonic acid and carbon monoxide were both found to be effective methane suppressors. An analysis of the energy outputs and requirements for the production of liquid hydrocarbon fuel from corn has been performed. As a means of expanding the number of potential substrates, pretreatment schemes are being investigated. A

tapered auger device has been designed and built which has been demonstrated on the bench to be effective for adding substrate and removing residue in a continuous manner from a fixed packed bed fermenter. A solvent extractor system using kerosene as the nonaqueous phase has been constructed and is currently in operation in series with the 300 liter fixed packed bed fermenter. Although additional work is required to optimize the electrolysis process, the electrolytic oxidation of organic acids produced in the 300 liter fixed packed bed fermenter is operating with a favorable energy balance of 6/1 based on the applied potential.

27105 (DOE/ET/20071—T1) **Production of sugarcane and tropical grasses as a renewable energy source. Third quarterly report, December 1, 1979-February 29, 1980.** Alexander, A.G.; Allison, W.; Garcia, M.; Ramirez, G.; Chu,T.L.; Velez-Santiago, J.; Smith, L. (Puerto Rico Univ., Rio Piedras. Agricultural Experiment Station). 1980. Contract ET-78-S-05-5912. 39p. NTIS, PC A03/MF A01.

Research continued on tropical grasses from Saccharum and related genera as sources of intensively-propagated fiber and fermentable solids. Both complete and incomplete data from the first three quarters of year 3 were reviewed. Candidate screening (for short-rotation grasses) was expanded to include six sorghum x Sudan grass hybrids developed by the Dekalb Company. Incomplete data indicate that two of the new grasses might be comparable to the NK hybrids in total biomass production and drought tolerance. Sugarcane and napier grass yield trends in year 3 includes: (a) Increased yields with delay of harvest frequency; (b) lxck of response to close spacing; (c) a superiority of napier grass over sugarcane when harvested at intervals of six months or less; and (d), a general superiority of the sugarcane variety NCo 310 over varieties PR 980 and PR 64-1791. Delayed tasseling of a wild, early-flowering S. spontaneous hybrid enabled three crosses to be made in December using commercial hybrids as female parents. Approximately 1000 seedlings were produced.

27106 **Solar energy utilization in photosynthesis.** Forti, G. (Instituto di Scienze Botaniche, Milan, Italy). pp 375-378 of Energy and physics. Petit-Lancy, Switzerland; European Physical Society (1976).

From 3. conference of the European Physical Society; Bucharest, Romania (9 Sep 1975).

The biochemical mechanisms involved in photosynthesis are reviewed. The possibilities of solar energy capture and storage by photosynthetic apparatus are discussed. Specifically, hydrogen production by biophotolysis, direct utilization of the photosynthetic apparatus in photovoltaic cells, and municipal sewage treatment are discussed. (DC)

27107 (MASEC/R—79-034) **Mid-American Biomass Energy Workshop May 21-23, 1979. Conference proceedings including recommendations for: direct combustion, alcohol fuels, anaerobic digestion, and gasification.** (Mid-American Solar Energy Complex, Bloomington, MN (USA)). Nov 1979. Contract EM-78-C-01-5137. 171p. NTIS, PC A08/MF A01.

Proceedings of the Biomass Energy Workshop are reported. The following topics were discussed: biomass energy utilization today in Mid-America; the potential for biomass production in Mid-America; policies, systems, and transportation issues related to biomass utilization; direct combustion of biomass; anaerobic digestion; alcohol fuels from biomass; gasification of biomass; and recommendations from the current sessions. (DC)

27108 (NP—24432) **Agri-fuel potentials of butanol/acetone production: an alternative to ethanol for a gasoline substitute.** Noon, R. (Kansas Energy Office, Topeka (USA)). 11 Feb 1980. 10p. NTIS, PC A02/MF A01.

Butanol and acetone can be produced via a fermentation process similar to ethanol. Butanol/acetone fuel mixtures offer several advantages over straight ethyl alcohol/water fuel mixtures. Whereas ethanol fuels require licensing and strict observance of federal and state laws, butanol and acetone are not regulated. These and other advantages may make the production of butanol/acetone fuels from renewable agricultural resources an alternative choice for a gasoline substitute.

27109 (NP—24434) **Upper bound estimates of potential methane production in Kansas: a preliminary estimate of the amount of methane that can be produced in Kansas by the anerobic digestion of livestock waste.** Noon, R. (Kansas Energy Office, Topeka (USA)). Apr 1980. 15p. NTIS, PC A02/MF A01.

The advantages of using methane as an energy source are discussed. The conversion of animal wastes to methane and the use of the remaining substrate as a nitrogen enriched fertilizer are also discussed. The present state of methane production in Kansas is described. (DC)

27110 (NP—24438) **Upper bound estimates of Kansas alcohol production potential.** Noon, R. (Kansas Energy Office, Topeka (USA)). Jan 1980. 12p. NTIS, PC A02/MF A01.

In general, the upper limit of approximately 300,000,000 gallons of neat alcohol is more than enough to make gasohol for the whole state. However, the gasoline replacement that this represents is 17%. This indicates that while alcohol production via starch conversion will help extend gasoline supplies in Kansas, it cannot be expected to replace more than a fraction of historical gasoline consumption, even under the most favorable conditions. However, the fraction of fuel consumption that it can replace is about the amount that the agricultural sector consumes. It would be reasonable then to assume that the agricultural sector, which produces this fuel, could eventually consume most of it. The purpose of this paper has been to define the upper bounds of ethyl alcohol production in Kansas using grain availability and by-product consumption capacity as limiting factors. The general system economics, energy balance, and other topics are not specifically addressed. However, even putting those issues aside, starch conversion to ethyl alcohol has obvious limitations to the magnitude of production possible. Other fuel producing schemes will also be needed to further supplement the replacement of import-based gasoline.

27111 (ORNL/MIT—307) **Recovery of neutral-solvent fermentation products.** Grosset, A.M.; Fok, S.K.; Lemarchand, M. (Oak Ridge National Lab., TN (USA); Massachusetts Inst. of Tech., Oak Ridge, TN (USA). School of Chemical Engineering Practice). Jun 1980. Contract W-7405-ENG-26. 27p. NTIS, PC A03/MF A01.

The economics of several separation techniques (distillation, crystallization, and solvent extraction) were evaluated for use as a preliminary step in the recovery of neutral solvents from a fermenter exit stream containing primarily n-butanol, isopropanol, ethanol, and water. A comparison of the resulting costs indicated that distillation is substantially less expensive than crystallization for 1979 pricing. No economic study was performed for solvent extraction because the separation was poor.

27112 (SAN—0115-T9) **Mission analysis for the Federal Fuels from Biomass program. Volume VII. Program recommendations. Final report.** Schooley, F.A.; Dickenson, R.L.; Kohan, S.M.; Jones, J.L. (SRI International, Menlo Park, CA (USA)). Dec 1978. Contract AT03-76ET20064. 28p. NTIS, PC A03/MF A01.

Based only on market penetration projections, the missions that appear to have the greatest near term commercialization potential are: combustion of wood and low moisture plants to produce steam and steam with electricity as a by-product; gasification of wood and low moisture plants to produce IBG, SNG, LBG, and ammonia; pyrolysis of wood and low moisture plants to produce IBG, fuel oil, and char; and anaerobic digestion of manure and high moisture terrestrial crops to produce intermediate Btu gas (IBG) and synthetic natural gas (SNG). The following program recommendations are listed roughly in order of importance. They are to: (1) Continue field biomass production experiments to establish promising plant species and yields followed by demonstration farms. (2) Continue a comprehensive research effort to improve the cost effectiveness of energy crop growth, and establish a formal program to improve the productivity of biomass field drying, densification, harvesting, collection, transportation and storage methods. (3) Investigate the development of cogeneration and cocombustion systems, minimize the effect of biomass seasonal availabilities, and with multiple end-products provide flexibility to serve customer needs. (4) Encourage the development of energy crops with many potential end-products in addition to fuels. (5) Expand development efforts designed to improve conversion process operations. (6) Expand development efforts designed to adapt or transfer coal gasification technology for use with biomass feedstocks. (7) Continue the current research on anaerobic digestion processes to examine the degradability and conversion of lignocellulosic materials, to optimize yields, and to reduce retention times. (8) Continue some program plans to reduce fermentation process costs. (9) Complete aquatic plant production demonstration projects designed to obtain verifiable long-term crop production yields.

27113 **Petroleum plantations.** Calvin, M. (Univ. of California, Berkeley). pp 1-30 of Solar energy: chemical conversion and storage. Hautala, R.R.; King, R.B.; Kutal, C. (eds.). Clifton, NJ; Humana Press, Inc. (1979).

From Southeastern meeting of the American Chemical Society; Savannah, GA, USA (8 Nov 1978).

Photosynthesis is examined as an annually renewable resource for material and energy. The production of fermentation alcohol from sugar cane as a major source of materials for chemical feedstocks is examined as well as the direct photosynthetic production of hydrocarbons from known plant sources. Experiments are underway to analyze the hydrocarbons from Euphorbias and other hydrocarbon containing plants with a view toward determining their various chemical components. In addition, experimental plantings of several species of Euphorbias have begun to obtain data on which species would be most successful. Using Euphorbia lathyris, there are indications that we may expect a yield of approximately ten barrels of hydrocarbon material per acre in a seven-month growing period on semiarid land.

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

REFER ALSO TO CITATION(S) 27044

27114 (SERI/TP—623-643) **Effects of temperature and intensity on thermodynamic limits for efficiencies of photochemical conversion of solar energy.** Bilchak, R.V.; Connolly, J.S.; Bolton, J.R. (Solar Energy Research Inst., Golden, CO (USA); Western Ontario Univ., London (Canada)). Jun 1980. Contract AC02-77CH00178. 6p. (CONF-800604—26). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

The subject of thermodynamic limits on photochemical conversion of light to work has been of considerable interest for over twenty years. Recently, Ross and Hsiao calculated quantum conversion efficiencies for solar radiation at air mass zero (AMO). Bolton later extended this treatment to AM1.2 solar flux and also considered some kinetic as well as thermodynamic limitations. These methods are applied to a variety of solar intensities and absorber temperatures. Also, improvements in efficiency which can be obtained by using systems with several absorbers of different effective band-gap wavelengths are examined. The results, which are applicable to photovoltaic as well as to photochemical and photobiological conversion devices, represent absolute (i.e., ideal) upper limits on conversion efficiencies, analogous to Carnot efficiencies of heat engines. Also, calculations for two-photon processes (i.e., two discrete absorbers) are carried out over a limited range of temperature-intensity combinations. The treatment is extended to calculate the optimum wavelengths for multiphoton cases ($3 \leqq n \leqq 8$) at fixed temperature and intensity. (WHK)

27115 **Solar energy: chemical conversion and storage.** Hautala, R.R.; King, R.B.; Kutal, C. (eds.). Clifton, NJ; Humana Press, Inc. (1979). 429p. (CONF-781140—).

From Southeastern meeting of the American Chemical Society; Savannah, GA, USA (8 Nov 1978).

The sixteen papers were entered into the data base separately. (WHK)

27116 **Tandem photoelectrolysis plant concept: a strategy for fuel production via biomass conversion wastes.** Schwerzel, R.E.; Brooman, E.W.; Craig, R.A.; Levey, D.D.; Moore, F.R.; Vaaler, L.E.; Wood, V.E. (Battelle Columbus Labs., OH). pp 83-115 of Solar energy: chemical conversion and storage. Hautala, R.R.; King, R.B.; Kutal, C. (eds.). Clifton, NJ; Humana Press, Inc. (1979).

From Southeastern meeting of the American Chemical Society; Savannah, GA, USA (8 Nov 1978).

One often-overlooked difficulty associated with the solar photoelectrolysis of water is the potential explosion hazard posed by the simultaneous evolution of hydrogen and oxygen. This problem can be addressed, in principle, by the addition of suitably chosen redox electrolytes to the photoelectrolysis cell. We have found, as have A.J. Bard and his coworkers, that the evolution of oxygen can be suppressed completely in certain aqueous photoelectrolysis cells, with no adverse effect on either the photocurrent or the rate of cathodic hydrogen evolution, by simple carboxylate ions such as acetate or butyrate. In basic solutions, water-soluble products derived from the carboxylate ions are formed at the photoanode, but in acidic solutions, hydrocarbons such as ethane or hexane are formed (along with CO_2) via a photo Kolbe reaction. Such cells can therefore produce a valuable fuel mixture, consisting of hydrogen (from the cathode) and hydrocarbons (from the photoanode). Because both acetic acid and butyric acid are abundantly available in the aqueous effluent from the enzymatic digestion of bimass material, these observations lead to the concept of a tandem photoelectrolysis plant, in which a photoelectrolysis device would derive its input water supply from a biomass conversion device. While the problems of electode stability and light absorption still remain to be solved, the approach described completely eliminates the necessity of separating the anodic and cathodic gases produced in photoelectrolysis. This, in turn, can pave the way for the design of simple and less expensive photoelectrolysis plants than would otherwise be possible.

27117 **Effect of the micellar phase on photo-induced reactions.** Thomas, J.K. (Univ. of Notre Dame, IN). pp 141-152 of Solar energy: chemical conversion and storage. Hautala, R.R.; King, R.B.; Kutal, C. (eds.). Clifton, NJ; Humana Press, Inc. (1979).

From Southeastern meeting of the American Chemical Society; Savannah, GA, USA (8 Nov 1978).

The effect of phase on electron ejection and electron transfer processes is discussed. In particular the effect of micellar systems on the efficiency of these processes and the decreased energy for threshold is illustrated and evaluated for the possible application to storage of solar energy.

27118 **Photochemical determinants of the efficiency of photogalvanic conversion of solar energy.** Hoffman, M.Z.; Lichtin, N.N. (Boston Univ., MA). pp 153-187 of Solar energy: chemical conversion and storage. Hautala, R.R.; King, R.B.; Kutal, C. (eds.). Clifton, NJ; Humana Press, Inc. (1979).

From Southeastern meeting of the American Chemical Society; Savannah, GA, USA (8 Nov 1978).

A photogalvanic cell is a battery in which the cell solution absorbs light directly to generate species which, upon back reaction through an external circuit with the aid of suitable electrodes, produces electric power; photoactivation of the electrodes is not involved. The charge-carrying species have storage capacity if they are long-lived and can be prevented from engaging in degradative back reactions in bulk solution. The efficiency of a photogalvanic cell for the conversion of photon energy into electrical energy is determined by photochemical and electrochemical factors. Among the latter are the choice of electrode materials and the kinetics of electron transfer at the heterogeneous surfaces. In this paper we examine the photochemical determinants of the efficiency of photogalvanic cell operation: the absorption spectral characteristics of the cell solution, the efficiency of formation of separated charge carriers, and the lifetimes of the carriers toward back electron transfer. Modulation of bulk solution dynamics can be achieved by variation of the solution medium. The photochemical determinants are discussed with particular reference to the use of thionine or Ru(bpy)2/3* as the light absorbing species. (76 references)

27119 **Photosensitization mechanisms for energy storing isomerizations.** Jones II, G.; Xuan,P.T.; Chiang, S.H. (Boston Univ., MA). pp 271-298 of Solar energy: chemical conversion and storage. Hautala, R.R.; King, R.B.; Kutal, C. (eds.). Clifton, NJ; Humana Press, Inc. (1979).

From Southeastern meeting of the American Chemical Society; Savannah, GA, USA (8 Nov 1978).

The prospects for driving endoergic reactions of simple, relatively abundant, organic chemicals by photochemical means have been examined. Photoisomerization reactions which have some potential for storage of solar energy as latent heat in kinetically stable products are surveyed. Emphasis is placed on methods for the photosensitization of storage chemicals to visible light. Mechanisms include excited state complexation of isomerizable substrates through electron donor-acceptor attraction and conventional energy transfer photosensitization. Efficient isomerization of a norbornadiene derivative using the latter technique and photosensitizers absorbing past 500 nm is described. Factors controlling the efficiency of endothermic triplet energy transfer are outlined. The concept of thermal upconversion of the excitation energies of visible absorbing sensitizers is introduced, including a demonsration of improved quantum efficiency as a function of temperature for an isomerization which utilizes a very low energy sensitizer. 50 references.

27120 **Norbornadiene-quadricyclene energy storage system.** Hautala, R.R.; King, R.B.; Kutal, C. (Univ. of Georgia, Athens). pp 333-369 of Solar energy: chemical conversion and storage. Hautala, R.R.; King, R.B.; Kutal, C. (eds.). Clifton, NJ; Humana Press, Inc. (1979).

From Southeastern meeting of the American Chemical Society; Savannah, GA, USA (8 Nov 1978).

The norbornadiene-quadricyclene interconversion is an excellent system for evaluating the feasibility of using reversible photoisomerization reactions for the conversion and storage of solar energy. When the features of the system are tested against the stringent practical criteria imposed by the nature of the energy source (sunlight) and the applications, the likelihood for potential use appears to rest upon surmounting several obstacles. In order to provide sufficient capacity, the light-gathering ability of such a system must be increased significantly. A possible means of easing this burden somewhat, through employment of the DUPLEX design, has been proposed. In order for any such system to be feasible from an economic point of view, all aspects of the chemistry must be rigorously quantitative. A rather hypothetical repair scheme to assist an unwilling system in this regard is proposed. Highly effective photosensitization and catalysis under heterogeneous conditions are essential. Results of recent studies are reported in detail.

27121 **Photosensitization mechanisms for energy storing isomerizations.** Jones, G. II.; Xuan, P.T.; Chiang, S.H. (Boston Univ., MA). pp 271-298 of Solar energy: chemical conversion and storage. Hautala, R.R.; King, R.B.; Kutal, C. (eds.). Clifton, NJ; Humana Press, Inc. (1979).

The prospects for driving endoergic reactions of simple, relatively abundant, organic chemicals by photochemical means have been examined. Photoisomerization reactions which have some potential for storage of solar energy as latent heat in kinetically stable products are surveyed. Emphasis is placed on methods for the photosensitization of storage chemicals to visible light. Mechanisms include excited state complexation of isomerizable substrates through electron donor-acceptor attraction and conventional energy transfer photosensitization. Efficient isomerization of a norbornadiene derivative using the latter technique and photosensitizers absorbing past 500 nm is described. Factors controlling the efficiency of endothermic triplet energy transfer are outlined. The concept of thermal upconversion of the excitation energies of visible absorbing sensitiz-

ers is introduced, incuding a demonstration of improved quantum efficiency as a function of temperature for an isomerization which utilizes a very low energy sensitizer.

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 27078, 27248, 27784

27122 (DOE/ET/20279—96) **Residential photovoltaic systems costs.** Cox, C.H. III. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract AC02-76ET20279. 8p. (CONF-800806—17). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

A study of costs associated with the installation and operation of a residential photovoltaic system has been conducted to determine present and projected (1986) status. As a basis for the study, a residential photovoltaic system design projected for 1986 was assumed, consisting of two principal components: a roof-mounted array and a utility-interactive inverter. The scope of the study encompassed both silicon and cadmium sulfide photovoltaic modules. Cost estimates were obtained by a survey and study of reports generated by companies and agencies presently active in each of the subsystem area. Where necessary, supplemental estimates were established as part of this study. The range of estimates for silicon-based systems strongly suggest that such systems will be competitive for new installations and reasonably competitive for retrofit applications. The cadmium-sulfide-based system cost estimates, which are less certain than those for silicon, indicate that these systems will be marginally competitive with silicon-based systems for new construction, but not competitive for retrofit applications. Significant variations from the DOE system price sub-goals were found, however, particularly in the areas of array mounting, wiring and cleaning. Additional development work appears needed in these areas.

27123 (DOE/ET/20279—99) **Residential photovoltaic systems.** Kern, E.C. Jr. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract AC02-76ET20279. 4p. (CONF-800806—21). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

The first residential photovoltaic systems built for the US Department of Energy's Solar Photovoltaic Residential Project will be designed and fabricated during 1980. These systems will be tested at the Northeast Residential Experiment Station in Concord, Massachusetts. Soon after these systems become operational, systems designed for the Southwest will become operational at the Southwest Residential Experiment Station in Las Cruces, New Mexico. In addition to the residential systems at the Residential Experiment Stations, DOE is supporting a small number of innovative system development efforts where unique circumstances promise early acceptance of photovoltaics. The status of each of these activities is reported. Innovative features of the various systems under development are emphasized and insights into future residential system development activities presented.

27124 (JPL-PUB—80-22) **Photovoltaic Residential Applications Program implementation workshop proceedings.** (Jet Propulsion Lab., Pasadena, CA (USA)). 15 May 1980. Contract AI01-76ET20356. 166p. NTIS, PC A08/MF A01.

A workshop was held at the California Institute of Technology on February 12-13, 1980 to discuss factors which would impact the implementation of a Photovoltaic Residential Applications Program. Sponsored by the Jet Propulsion Laboratory (JPL), this workshop brought together twenty-six individuals from private industry, universities, national laboratories, and the Department of Energy (DOE). The workshop consisted of four sessions composed of brief presentations by participants and moderated discussions. The first session was an introduction to the Photovoltaics Program as a context for the Residential Applications Program. The second session discussed the Solar Heating and Cooling Demonstration program and the structure and operation of the residential market. The third session studied the factors to be considered in the design of non-hardware experiments. The fourth session consisted of a working forum in which the ideas and suggestions from the previous sessions were summarized and synthesized. The agenda for the Photovoltaic Residential Application Program Implementation Workshop (Appendix A) shows how the workshop was broken down into the various presentations and topics discussed. Copies of the conference viewgraphs (Appendix B) provide further detail on the presentations. Remarks from attendees (Appendix C) are included with suggestions stimulated from the workshop. A bibliography (Appendix D) indicates the amount of information available on issues relevant to the program. It is no way inclusive nor does it indicate a higher value of those documents over those not included. Preconference communications and a list of attendees (Appendix E) are also included.

27125 (SAND—79-7018/1) **Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume I. Executive summary.** Mengel, R.W.; Nadolski, T.P.; Sparks, D.C.; Young, S.K.; Yingst, A. (BDM Corp., McLean, VA (USA)). May 1980. Contract AC04-76DP00789. 66p. NTIS, PC A04/MF A01.

Study results of identification and characterization of agricultural energy demands that can effectively use photovoltaic power systems, conceptual designs and performance analysis for selected applications, and conclusions and recommendations are presented. This volume presents an overview of the project results, the technical work accomplished, and the approach taken to achieve the project objectives. (WHK)

27126 (SAND—79-7018/2) **Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume II. Technical results.** Mengel, R.W.; Nadolski, T.P.; Sparks, D.C.; Young, S.K.; Yingst, A. (BDM Corp., McLean, VA (USA)). May 1980. Contract AC04-76DP00789. 230p. NTIS, PC A11/MF A01.

This volume describes the technical results of the study of potential photovoltaic (P/V) applications in US agriculture. The results presented address all technical aspects of the program and include a summary of agricultural energy consumption. The objectives of the technical effort reported have been to: (1) identify and characterize agricultural energy demands that can effectively use P/V power systems; (2) develop effective P/V system designs for the four most promising applications; (3) determine performance and cost-estimates for the designs; and (4) recommend systems for early test and demonstration and critical issues requiring further systems studies. The farms chosen for conceptual design include: (1) poultry layer farm, (2) hog production farm, (3) beef feedlot, and (4) year-round vegetable farm. (WHK)

27127 (SAND—79-7018/3) **Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume III. Appendixes.** Mengel, R.W.; Nadolski, T.P.; Sparks, D.C.; Young, S.K.; Yingst, A. (BDM Corp., McLean, VA (USA)). May 1980. Contract AC04-76DP00789. 221p. NTIS, PC A10/MF A01.

The appendices presented in this volume include: (1) description of energy consumption for representative farm operations; (2) design and simulation of ventilation for livestock shelters; (3) irrigation systems and calculations; (4) detailed methodology for selecting multifunction PV system applications; (5) hourly load data for the chosen farm operations; (6) sample linear programming solution output format; (7) life cycle cost calculation; and (8) illustrative monthly load data for applications analysis and equipment data for applications analysis. (WHK)

27128 (SAND—80-0220C) **Sandia battery program for energy storage in photovoltaic systems.** Caskey, D.L.; Clark, R.P.; Verardo, A.E. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 14p. (CONF-800806—24). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

Sandia Laboratories has management responsibility for the DOE-funded program for the development of battery technology for storage of photovoltaic energy. The objectives of the program are 1) to conduct detailed systems analysis based on cost projections and technical considerations to define battery requirements for various specific photovoltaic system configurations and applications, 2) to conduct laboratory evaluations and photovoltaic systems testing of selected battery systems to confirm or refine the battery requirements analysis, 3) to identify significant differences between battery requirements and existing battery technology, and 4) to define and support the necessary research and development required to bring the battery technology level in line with the systems requirements. An overview of this program is given, and results to date are discussed.

27129 (SAND—80-0853C) **Intermediate load-center photovoltaic application experiments.** Burgess, E.L. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 5p. (CONF-800806—11). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

A total of nine intermediate load-center photovoltaic systems were carried into the construction phase this year. These nine systems range in size from 20 to 225 kW/sub p/ electrical output and total almost 1 MW/sub p/. They are being installed in a diverse set of applications and locations and represent the bulk of the photovoltaic initial system evaluation experiments (ISEE) for the intermediate load-center sector. Each of these experiments are briefly de-

scribed and the status of the construction phase is given for each project.

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 27168

27130 (COO—4878-14) **High-temperature ceramic receivers.** Jarvinen, P.O. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract ET-78-S-02-4878. 8p. (CONF-800639—1). NTIS, PC A02/MF A01.

From International symposium on solar thermal power; Marseilles, France (15 Jun 1980).

An advanced ceramic dome cavity receiver is discussed which heats pressurized gas to temperatures above 1800°F (1000°C) for use in solar Brayton power systems of the dispersed receiver/dish or central receiver type. Optical, heat transfer, structural, and ceramic material design aspects of the receiver are reported and the development and experimental demonstration of a high-temperature seal between the pressurized gas and the high-temperature silicon carbide dome material is described.

27131 (DOE/JPL—1060-33, pp 235-239) **50-horsepower solar-powered irrigation facility located near Gila Bend, Arizona.** Smith, W.A.; Alexander, G.; Busch, D.F. (Battelle Columbus Labs., OH). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The operation of the 50-horsepower solar-powered irrigation facility near Gila Bend, Arizona over three years demonstrates the technical feasibility of solar-powered pumping. The Rankine cycle facility was built using 1976 technology. The requirement now is to use the technology that has been developed over the last four years to design a facility specifically for the irrigation farmer. Considerations to meet his needs and to demonstrate whether solar thermal conversion is a potentially viable application for pumping irrigation water in the United States are suggested.

27132 (SAND—80-8212) **Design and operation of thermal convection loops for corrosion testing in molten $NaNO_3$ - KNO_3.** Winters, W.S.; Bradshaw, R.W.; Hart, F.W. (Sandia National Labs., Livermore, CA (USA)). Jun 1980. Contract AC04-76DP00789. 32p. NTIS, PC A02/MF A01.

Convective loop experiments are a valuable and relatively inexpensive method of assessing the effects of mass transport and a fully operational temperature gradient on molten salt materials compatibility. This report documents the design, construction, operation, and preliminary results of three molten draw salt corrosion loop experiments conducted at SLL. The loops were constructed from 304 SS, 316 SS, and Incoloy 800. This effort was undertaken to support the DOE program for Thermal Energy Storage for Solar Thermal Applications.

DISTRIBUTED COLLECTOR

REFER ALSO TO CITATION(S) 27166

27133 (DOE/ET/20419—1) **Solar powered Rankine cycle irrigation pump. Final report.** Batton, W.D.; Barber, R.E. (Barber-Nichols Engineering Co., Arvada, CO (USA)). Sep 1979. Contract AC03-78ET20419. 87p. (SAN—0419-1). NTIS, PC A05/MF A01.

A new and novel means of combining solar energy with the Rankine engine is to use the collectors as the engine boiler. This report details the results of a test program where a small (288 square feet) collector field was installed and used for boiling-in-the-collector tests with R-113 as a working fluid. Two different types of parabolic trough tracking collectors were purchased and tested. There were two rows (128 sq. ft.) of Del Manufacturing collectors and one row (160 sq. ft.) of Solar Kinetics collectors. All three rows were installed at a 5 degree angle (inclined to the South) oriented North-South and tracking East-West on the roof at Barber-Nichols in Arvada, Colorado, a northwest suburb of Denver. These two types of collectors have distinct differences that made it worthwhile to test each type. A Rankine engine, less turbine expander, was installed and used to complete a solar power system. The major experimental results are that the collectors did heat the R-113, did provide a vapor suitable for turbine feed, and stable flow did occur under all conditions, thus proving the feasibility of the boiling-in-collector concept. Also, the 5 degree angle performed satisfactorily and is considered a reasonable angle for field use. Some unexpected problems were experienced in testing the collectors. The feasibility of the system concept has been demonstrated and areas for improvement have been determined. Methods to resolve these areas are proposed along with a plan to expand the system, complete the engine, and to gather operating experience and performance data for a year's operation. Budget and schedule are provided for this proposed follow on work. (WHK)

27134 (DOE/JPL—1060-33, pp 241-246) **Preliminary operational results from the Willard Solar Power System.** Fenton, D.L.; Abernathy, G.H.; Krivokapich, G.; Ellibee, D.E.; Chilton, V. (New Mexico State Univ., Las Cruces). 15 Apr 1980.

In Proceedings of the first semi-annual Distributed Receiver Systems Program Review.

The solar-powered system located near Willard, New Mexico, generates mechanical or electrical power at a capacity of 19kW (25 HP). The solar collection system incorporates east/west tracking parabolic trough collectors with a total aperture area of 1275m^2 (13720 ft^2). The hot oil type thermal energy storage is sufficient for approximately 20 hours of power system operation. The system utilizes a reaction-type turbine in conjunction with an organic Rankine cycle engine. Total collector field efficiency reaches a maximum of 20% near the winter solstice and about 50% during the summer. During the month of July 1979, the system pumped 60% of the 35,300m^3 (28.6 acre-feet) of water delivered. Operating efficiencies for the turbine component, organic Rankine cycle engine and the complete power system are respectively 65 to 75%, 12 to 15% and 5 to 6%. Significant maintenance time was expended on both the collector and power systems throughout the operational period.

27135 **Solar powered deep well pumping experiment.** Larson, D.L.; Sands, C.D. II. (Univ of Ariz, Tucson). *ASAE Tech. Pap.;* 7(1979). (CONF-7906167—).

From ASAE and CSAE Canadian Society of Agricultural Engineering summer meeting; Winnipeg, Canada (24 Jun 1979).

The paper discusses the design, construction, operation and evaluation of a 150 kW solar power plant. Plant size was selected to meet the energy requirements of deep well pumping to provide irrigation water for a quarter section or 160 acres of Arizona cropland. An important factor in site selection was cooperation of the local utility company. Backup energy is required to assure pump operation. The plant includes parabolic trough type collectors and Rankine cycle turbine engine. The plant will generate electricity for pumping and be interconnected with the utility system. Refs.

27136 **Operational characteristics of a medium temperature solar power system.** Abernathy, G.H. (NM State Univ, Las Cruces). *ASAE Tech. Pap.;* 11(1979). (CONF-7906167—).

From ASAE and CSAE Canadian Society of Agricultural Engineering summer meeting; Winnipeg, Canada (24 Jun 1979).

A medium temperature solar thermal power facility for pumping irrigation water has been designed and constructed at Willard, New Mexico. Mechanical difficulties with the early prototype equipment have delayed collection of operation and maintenance data. Short term observational data indicate that components operate near their design efficiencies.

TOTAL ENERGY AND HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 27165

27137 (DOE/ET/21050—1/1) **Combined cycle solar central receiver hybrid power system study. Volume I. Executive summary. Final technical report.** (Bechtel National, Inc., San Francisco, CA (USA)). Nov 1979. Contract ET-78-C-03-2051. 111p. NTIS, PC A06/MF A01.

The results of the Combined Cycle Solar Hybrid Power System Study Project are summarized in this Executive Summary. The project is part of the US Department of Energy's Solar Central Receiver Hybrid Power System program. The major effort of the project was development and assessment of a commercial-scale power plant concept where both solar energy and fossil fuel are used to generate electricity. This so called hybrid concept was developed around a combined cycle gas turbine/steam turbine power plant. The scope of the study project included a market analysis, and parametric and system studies, leading to a comparative evaluation of the Modified Strawman and Advanced Strawman systems. (WHK)

27138 (DOE/ET/21050—1/2) **Combined cycle solar central receiver hybrid power system study. Final technical report. Volume II.** (Bechtel National, Inc., San Francisco, CA (USA)). Nov 1979. Contract ET-78-C-03-2051. 491p. NTIS, PC A21/MF A01.

This study develops the conceptual design for a commercial-scale (nominal 100 MWe) central receiver solar/fossil fuel hybrid power system with combined cycle energy conversion. A near-term, metallic heat pipe receiver and an advanced ceramic tube receiver hybrid system are defined through parametric and market potential analyses. Comparative evaluations of the cost of power generation, the fuel displacement potential, and the technological readiness of these two systems indicate that the near-term hybrid system has better potential for commercialization by 1990. Based on the assessment of the conceptual design, major cost and performance improve-

ments are projected for the near-term system. Constraints preventing wide-spread use were not identified. Energy storage is not required for this system and analyses show no economic advantages with energy storage provisions. It is concluded that the solar hybrid system is a cost effective alternative to conventional gas turbines and combined cycle generating plants, and has potential for intermediate-load market penetration at 15% annual fuel escalation rate. Due to their flexibility, simple solar/nonsolar interfacing, and short startup cycles, these hybrid plants have significant operating advantages. Utility company comments suggest that hybrid power systems will precede stand-alone solar plants.

27139 (DOE/ET/21050—1/3) **Combined cycle solar central receiver hybrid power system study. Volume III. Appendices. Final technical report.** (Bechtel National, Inc., San Francisco, CA (USA)). Nov 1979. Contract ET-78-C-03-2051. 177p. NTIS, PC A09/MF A01.

A design study for a 100 MW gas turbine/steam turbine combined cycle solar/fossil-fuel hybrid power plant is presented. This volume contains the appendices: (a) preconceptual design data; (b) market potential analysis methodology; (c) parametric analysis methodology; (d) EPGS systems description; (e) commercial-scale solar hybrid power system assessment; and (f) conceptual design data lists. (WHK)

27140 (ORNL/TM—7022) **Comparison of solar-thermal and fossil total-energy systems for selected industrial applications.** Pine, G.D. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 75p. NTIS, PC A04/MF A01.

Economic analyses of a conventional system (grid-electric-package-boiler) and total-energy systems based on phosphoric acid fuel cells, diesel-piston engines, and central-receiver-solar-thermal systems were performed for each of four industrial applications: a concrete block plant in Arizona, a fluid milk processing plant in California, a sugar beet processing plant in Colorado, and a meat-packing plant in Texas. The industrial application data were based on existing facilities, and reference case analyses were for a single plant size for each industry. However, scaled loads were used to explore the effects of system size on the relative economics of the four systems. All total-energy systems were assumed to be isolated from the electrical grid, but fossil-fueled boilers were assumed to provide thermal backup for solar collectors during prolonged periods of low insolation. Insolation data and fuel price projections appropriate to the plant locations were used to develop system cost and performance information. All systems were assumed to operate between 1985 and 2015. A series of sensitivity analyses was performed to show the effects of variations in fuel price, system size, cost of capital, and system initial cost. Solar total-energy systems (STES) are more capital intensive than the other systems, and significant economies of scale are associated with the STES. If DOE solar system cost goals are met, STES can compete with the other systems for facilities with electrical demands greater than two or three megawatts, but STES are not competitive for smaller facilities. Significant energy resource savings, especially of oil and gas, resulted from STES implementation in the four industries.

OCEAN THERMAL GRADIENT POWER PLANTS

27141 (ANL/OTEC-BCM—009) **Localized corrosion of aluminum alloys for OTEC heat exchangers.** Dexter, S.C. (Delaware Univ., Newark (USA). Coll. of Marine Studies; Argonne National Lab., IL (USA)). Jan 1979. Contract AS02-76ET20285;W-31-109-ENG-38. 58p. NTIS, PC A04/MF A01.

The effects of dissolved oxygen, pH and temperature on the rate of initiation and growth of pitting and crevice corrosion of aluminum alloy 5052 and pure aluminum have been determined. Variations in pH and temperature rather than dissolved oxygen are shown to account for increased corrosion rates of 5000 series aluminum alloys that have been reported for deep ocean exposures. The impact of these results on the use of aluminum for OTEC heat exchanger tubing and on possible approaches to corrosion control are discussed.

27142 (DOE/NOAA/OTEC—31) **Ocean thermal energy conversion cold water pipe preliminary design project. Task 2. Analysis for concept selection.** (TRW Defense and Space Systems Group, Redondo Beach, CA (USA)). Apr 1979. Contract EG-77-A-29-1078. 254p. NTIS, PC A12/MF A01.

The successful performance of the CWP is of crucial importance to the overall OTEC system; the pipe itself is considered the most critical part of the entire operation. Because of the importance the CWP, a project for the analysis and design of CWP's was begun in the fall of 1978. The goals of this project were to study a variety of concepts for delivering cold water to an OTEC plant, to analyze and rank these concepts based on their relative cost and risk, and to develop preliminary design for those concepts which seemed most promising. Two representative platforms and sites were chosen: a spar buoy of a Gibbs and Cox design to be moored at a site off Punta Tuna, Puerto Rico, and a barge designed by APL/Johns Hopkins University, grazing about a site approximately 200 miles east of the coast of Brazil. The approach was to concentrate on the most promising concepts and on those which were either of general interest or espoused by others (e.g., steel and concrete concepts). Much of the overall attention, therefore, focused on analyzing rigid and compliant wall design, while stockade (except for the special case of the FRP stockade) and bottom-mounted concepts received less attention. A total of 67 CWP concepts were initially generated and subjected to a screening process. Of these, 16 were carried through design analysis, costing, and ranking. Study results are presented in detail. (WHK)

27143 (DOE/NOAA/OTEC—31(APP.)) **Ocean thermal energy conversion cold water pipe preliminary design project. Appendices to Task 2. Analysis for concept selection.** (TRW Defense and Space Systems Group, Redondo Beach, CA (USA)). Apr 1979. Contract EG-77-A-29-1078. 252p. NTIS, PC A12/MF A01.

Appendices include (A) TRW CWP/hull dynamics computer model (HULPIPE); (B) environmental data; (C) structural analysis methods; (D) work breakdown structure; (E) costing worksheets; (F) thermal design of the cold water pipe; (G) CWP/Platform transition ROM costs; (H) installation scenarios and costs; (I) cost uncertainty assessment; (J) risk assessment; and (K) OTEC cold water pipe concept catalog. (WHK)

27144 (DOE/NOAA/OTEC—33) **Evaluation of various predictive methods for determining OTEC SKSS environmental loads. Revision A, Report No. 79-049-004A.** (Giannotti and Associates, Inc., Annapolis, MD (USA)). 31 Oct 1979. Contract EG-77-A-29-1078. 78p. NTIS, PC A05/MF A01.

The NOAA Office of Engineering is presently managing two contracts for the preliminary design of the OTEC stationkeeping system. Results presented by the contractors thus far (draft report stage in conceptual design) indicate significant differences in the predicted environmental loads. The discrepancies were caused by the use of different prediction methods and variations in the description of the environment. In order to reconcile these discrepancies, a review, comparison, and assessment of the mooring system load prediction methods used by SKSS contractors was presented in Giannotti and Associates, Inc., Report Nos. 78-049-001, 002, and 003. A search for existing model test results and full scale experiments were conducted in an effort to compare results. The present report documents a study on the state of technology for the prediction of environmental loads in general and drift force loads in particular. The outcome of this study should provide: (1) a consistent approach to be taken by SKSS contractors; (2) levels of confidence to be associated with the predicted loads; and (3) a set of recommendations to be used by NOAA to increase confidence in the OTEC SKSS designs and to reduce the risk attributed to those designs. (WHK)

SOLAR RADIATION UTILIZATION

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 27063

27145 (CONF-791022—14) **RIB: reflective insulating blinds.** Shapira, H.B.; Barnes, P.R. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 12p. NTIS, PC A02/MF A01.

From 4. national passive solar energy conference; Kansas City, KS, USA (3 Oct 1979).

A novel type blind which reflects insolation as well as insulates is being developed and tested at Oak Ridge National Laboratory. The unit is called Reflective Insulating Blind (RIB). The purpose of the unit is to improve the performance of direct gain space heating systems. The RIB unit operates in both diurnal and seasonal modes. In winter, the daytime (i.e., open) mode allows the unit to reflect the solar radiation onto the ceiling; at night, it closes and serves as an insulating shutter. In summer, RIB may be used to reduce cooling loads. This paper establishes the need for RIB and discusses its design parameters, materials considerations, operational modes, and RIB's contribution to the performance of direct gain space heating.

27146 (DOE/NASA/CR—161436) **Solar heating system installed at Stamford, CT. Final report.** (Lutz-Sotire Partnership, Stamford, CT (USA)). Sep 1979. Contract AC01-76CS32377;AI01-76CS31024. 93p. NTIS, PC A05/MF A01.

Information is provided on the solar heating system installed at the Lutz-Sotire Partnership Executive East Office Building, Stamford, Connecticut. The information consists of description of system and components, operation and maintenance manual, as-built drawings and manufacturer's component data. The solar system was designed to provide approximately 50 percent of the heating require-

ments. The solar facility has 2,561 sq. ft. of liquid flat plate collectors and a 6000 gallon, stone lined, well-insulated storage tank. Freeze protection is provided by a 50 percent glycol/water mixture in the collector loop. From the storage tank, solar heated water is fed into the building's distributed heat pump loop via a modulating three-way valve. If the storage tank temperature drops below 80°F, the building loop may be supplied from the existing electrical hot water boilers. The Executive East Office Building is of moderate size, 25,000 sq. ft. of heated space in 2 1/2 stories. The solar system makes available for other users up to 150 KVA of existing electrical generating capacity.

27147 (DOE/NASA/CR—161464) **Solar energy system performance evaluation: seasonal report for IBM System IA, Huntsville, Alabama.** (IBM Federal Systems Div., Huntsville, AL (USA)). May 1980. Contract AI01-76CS31037. 84p. NTIS, PC A05/MF A01.

The analysis used is based on instrumented system data monitored and collected for at least one full season of operation. The long-term field performance of the installed system is reported. The Solar Energy System, Sims Prototype System 1A, was designed by IBM to provide 50 to 60% of the space heating and domestic hot water (DHW) preheating load to a 2000 square foot floor space single faily residence in the Huntsville area. The load design temperature inside the building was to be maintained at 70 degrees fahrenheit with auxiliary energy for heating supplied by an electric heat pump assisted by an electric resistance strip heater. Auxiliary energy for domestic hot water is from a conventional 20-gallon DHW storage tank. The solar energy system, uses air as the heat transport medium, has a 720 square foot Solar Energy Products Collector Array, a 22-ton rock storage located within the office building, a pump, heat exchanger, air handler, pre-heat tank, fan and associated plumbing. The system has five different modes of operation.

27148 (DOE/NASA/CR—161465) **Solar energy system performance evaluation: seasonal report for Solaron-Akron, Akron, Ohio.** (IBM Federal Systems Div., Huntsville, AL (USA)). May 1980. Contract AI01-76CS31037. 90p. NTIS, PC A05/MF A01.

The long-term field performance of the installed system and technical contributions to the definition of techniques and requirements for solar energy system design are reported. The Solar Energy System was designed by Solaron Corporation, Denver, Colorado, to provide an 1840 square foot floor area with space heating and domestic hot water (DHW) for a dual-level single family residence in Akron, Ohio. The Solar Energy System uses air as the heat transport medium, has a 546 square foot flat plate collector array subsystem, a 270 cubic foot rock thermal storage bin subsystem, a domestic hot water preheat tank, pumps, controls and transport lines. The auxiliary space heating subsystem is an air to liquid heat pump coupled with a 1000 gallon water storage tank. Electricity provides auxiliary energy for both space heating and DHW subsystems.

27149 (IS-M—277) **Solar heating performance results for a transwall test-prototype system.** Hull, J.R.; McClelland, J.F.; Hodges, L.; Fuchs, R.; Block, D.A. (Ames Lab., IA (USA)). 1980. Contract W-7405-ENG-82. 5p. (CONF-800604—29). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

The preliminary results of thermal performance for a Transwall passive solar heating system in a passive test room are presented. These results are compared with the simultaneously measured thermal performance of a Trombe wall structure in an adjacent test room. The results include operating modes with and without night insulation and for both a vented and unvented Trombe wall. In all cases the thermal performance of the unvented Transwall equalled or exceeded the corresponding performance of the Trombe wall under the conditions described. The construction of the experimental prototype Transwall modules is described. Light transmission through the modules and thermal stratification within the modules is also discussed.

27150 Predicting the effectiveness of solar system design for swine production. Schulte, D.D.; DeShazer, J.A.; Bodman, G.R.; Green, G. (Univ of Nebr, Lincoln). *ASAE Tech. Pap.;* 17(1979). (CONF-7906167—).

From ASAE and CSAE Canadian Society of Agricultural Engineering summer meeting; Winnipeg, Canada (24 Jun 1979).

A mathematical model was used to compare heating requirements of three types of modified-open-front swine growing-finishing buildings. Single- and double-glazed, fiberglass-reinforced, plastic ventilation panels reduced propane requirements when compared to opaque, insulated panels and curtain-wall systems. Double-glazed panels required less propane than single-glazed panels, but the optimum panel-to-floor-area ratio was less for the latter system. 10 refs.

27151 Multi-stage heat exchange system for a solar pond. Badger, P.C.; Short, T.H.; Roller, W.L. (Ohio Agric Res and Dev Cent, Wooster). *ASAE Tech. Pap.;* 26(1979). (CONF-7906167—).

From ASAE and CSAE Canadian Society of Agricultural Engineering summer meeting; Winnipeg, Canada (24 Jun 1979).

Alternative methods for heat extraction from a deep, nonconvecting solar pond were investigated. A pond heat extraction system, and a heat pump and direct hot water heating system were designed and constucted to heat an adjacent greenhouse. 12 refs.

27152 New AB_5 hydrides and their application in chemical heat pump systems. Gruen, D.M. (Argonne National Lab., IL); Mendelsohn, M.H.; Sheft, I.; Dwight, A.E. pp 371-393 of Solar energy: chemical conversion and storage. Hautala, R.R.; King, R.B.; Kutal, C. (eds.). Clifton, NJ; Humana Press, Inc. (1979).

From Southeastern meeting of the American Chemical Society; Savannah, GA, USA (8 Nov 1978).

The ability of AB_5 compounds (A = rare earth, B = transition metal) to form hydrides with quite unique properties has stimulated research and development in several areas. Although measurements of the physico-chemical properties of a number of AB_5 hydrides have been made, a detailed understanding of the factors that determine the hydrogen dissociation pressures of this class of materials is just beginning to emerge. The rapid kinetics of the reactions, $AB_5 + nH_2 = AB_5H_2$/sub 2n/ the high volumetric hydrogen storage densities and the wide range of hydrogen decomposition pressures available with the AB_5 hydrides have led to proposals for their use as chemical or thermally driven heat pumps. Since two different AB_5 alloys are involved, the relationship between their respective hydrogen decomposition pressures as a function of temperature is the key parameter determining the thermodynamics of heat pump action. It is crucial to discover the relationship between the chemical composition of the AB_5 compounds and their hydrogen decomposition pressures. Also, it is essentail that alloy systems be developed which allow one to have control over the free energies of formation so as to be able to change dissociation pressures in a continuous fashion over a wide range. Recent work has shown that Group III A and IV A substitutions for Ni in $LaNi_5$ are particularly effective in lowering the plateau hydrogen pressures. The results of Al, Ga, In, Si, Ge, and Sn substitutions presented and discussed in the light of several important theoretical considerations. The use of these materials in chemical heat pump applictions is also elucidated. (WHK)

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 26795, 27165

27153 (SERI/TP—632-584) **Potential for supplying solar thermal energy to industrial unit operations.** May, E.K. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract AC02-77CH00178. 13p. (CONF-800802—3). NTIS, PC A02/MF A01.

From 89. annual meeting of the American Institute of Chemical Engineers; Portland, OR, USA (17 Aug 1980).

Previous studies have identified major industries deemed most appropriate for the near-term adoption of solar thermal technology to provide process heat; these studies have been based on surveys that followed standard industrial classifications. This paper presents an alternate, perhaps simpler analysis of this potential, considered in terms of the end-use of energy delivered to industrial unit operations. For example, materials, such as animal feed, can be air dried at much lower temperatures than are currently used. This situation is likely to continue while economic supplies of natural gas are readily available. However, restriction of these supplies could lead to the use of low-temperature processes, which are more easily integrated with solar thermal technology. The adoption of solar technology is also favored by other changes, such as the relative rates of increase of the costs of electricity and natural gas, and by energy conservation measures. Thus, the use of low-pressure steam to provide process heat could be replaced economically with high-temperature hot water systems, which are more compatible with solar technology. On the other hand, for certain operations such as high-temperature catalytic and distillation processes employed in petroleum refining, there is no ready alternative to presently employed fluid fuels.

27154 Solar grain drying with a combination desiccant/low-temperature system. Bern, C.J.; Anderson, M.E.; Miranowski, J.A.; Wilcke, W.F. (Iowa State Univ, Ames). *ASAE Tech. Pap.;* 10(1979). (CONF-7906167—).

From ASAE and CSAE Canadian Society of Agricultural Engineering summer meeting; Winnipeg, Canada (24 Jun 1979).

Tests were conducted comparing corn drying in a combination desiccant/low-temperature system with drying in a conventional low-temperature system. Electrical energy use and demand for the combination system averaged 41 and 29 percent respectively of that required for the conventional system.

27155 Storage versus no-storage of solar heat for corn drying under Ohio conditions. Misra, R.N.; Keener, H.M.; Roller, W.L. (Ohio Agric Res and Dev Cent, Wooster). *ASAE Tech. Pap.;* 25(1979). (CONF-7906167—).

From ASAE and CSAE Canadian Society of Agricultural Engineering summer meeting; Winnipeg, Canada (24 Jun 1979).

Five year (1974-78) field drying results for no-storage low temperature drying at Wooster, Ohio, are presented. Results showing allowable investment in no-storage low temperature solar drying are presented as a function of system design. Energy storage analysis and simulated results showing the effect of increasing collector area and insulation volume, i.e. thickness, on energy storage is discussed along with allowable cost for heat storage. 11 refs.

27156 Solar supplemented hop drying. Kranzler, G.A.; Zimmerman, C.E. (Wash State Univ, Pullman). *ASAE Tech. Pap.;* 18(1979). (CONF-7906167—).

From ASAE and CSAE Canadian Society of Agricultural Engineering summer meeting; Winnipeg, Canada (24 Jun 1979).

A roof-mounted solar collector was installed on a conventional hop drying kiln to preheat system intake air. The solar installation was shown to be fully compatible with the existing drying system. Payback analysis indicated the solar contribution to be uneconomic at current fuel prices. With annual percentage increases in fuel costs and/or off-season collector use, attractive economic savings were projected. Refs.

27157 Simulation analysis of greenhouse solar drying system for peanuts and grains. Huang, B.K.; El-Shaik, N.M. (NC State Univ, Raleigh). *ASAE Tech. Pap.;* 19(1979). (CONF-7906167—).

From ASAE and CSAE Canadian Society of Agricultural Engineering summer meeting; Winnipeg, Canada (24 Jun 1979).

The studies described in this paper are the first phase in the application of electric circuit analog and digital simulation analysis techniques to obtain the temperature-time response of greenhouse solar drying system for peanuts and grains. Since the rotary solar drum unit is the major heat source in the system, the surface temperatures were computed based on the daily solar radiation. The curve for predicted drum surface temperatures are in good agreement with the measured data. The simulation analysis was performed using an electronic circuit analysis program to study the air temperature inside the solar drum. Measured air temperatures were also plotted for comparison. In general, the predictions of the thermal behavior of the greenhouse solar drying system are good. 19 refs.

WATER HEATING

REFER ALSO TO CITATION(S) 27063, 27147, 27148

27158 (DOE/NASA/CR—161449) **Test results on the Frenchman's Reef Solar Data Acquisition and Control System.** (Wyle Labs., Huntsville, AL (USA). Solar Energy Systems Div.). 15 Jan 1980. Contract AI01-76CS31037. 18p. NTIS, PC A02/MF A01.

The test procedures and the results obtained are described from an evaluation test program conducted on the Frenchman's Reef Data Acquisition and Control System (DACS), Sunlogger Model 10000-1, produced by Andover Controls Corporation. The purpose of the test program was to verify the accuracy of control functions and to determine the performance of the system in the environment of the planned installation site.

OTHER

REFER ALSO TO CITATION(S) 27135, 27136

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 27067, 27155

27159 (DOE/CS/15362—1) **Collector sealants and breathing. Final Report, 25 September 1978-31 December 1979.** Mendelsohn, M.A.; Luck, R.M.; Yeoman, F.A.; Navish, F.W. Jr. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). 20 Feb 1980. Contract AC04-78CS15362. 278p. NTIS, PC A09/MF A01.

The objectives of this program were: (1) to investigate the pertinent properties of a variety of possible sealants for solar collectors and identify the most promising candidates, and (2) to study the effect of breathing in flat-plate, thermal solar collector units. The study involved two types of sealants, Class PS which includes preformed seals or gaskets and Class SC which includes sealing compounds or caulks. It was the intent of the study to obtain data regarding initial properties of candidate elastomers from manufacturers and from the technical literature and to use those sources to provide data pertaining to endurance of these materials under environmental service conditions. Where necessary, these data were augmented by experimental measurements. Environmental stresses evaluated by these measurements included elevated temperatures, moisture, ultraviolet light, ozone and oxygen, and fungus. The second major area of the work involved a study of the effects of materials used and design on the durability of solar collectors. Factors such as design, fabrication, materials of construction, seals and sealing techniques and absorber plate coatings were observed on actual field units removed from service. Such phenomena as leakage, corrosion and formation of deposits on glazing and absorber plate were noted. An evaluation of the properties of several desiccants was made in order to provide means to mitigate the deleterious effects of water on collector life. Adsorbents for organic degradation products of sealants were also investigated in order to protect the glazing and absorber plate from deposited coatings. Since adsorbents and desiccants in general tend to take up both water and organic decomposition products, relative affinities of a number of these agents for water and for organic compounds were determined . Results are presented in detail.

27160 (DOE/ER/04657—2) **Fundamentals and techniques of nonimaging optics for solar energy concentration. Final report.** Winston, R. (Chicago Univ., IL (USA)). 20 May 1980. Contract AS02-78ER04657. 51p. NTIS, PC A04/MF A01.

Nonimaging optics is a new discipline with techniques, formalism and objectives quite distinct from the traditional methods of focusing optics. These new systems achieve or closely approach the maximum concentration permitted by the Second Law of Thermodynamics for a given angular acceptance and are often called ideal. Application of these new principles to solar energy over the past seven years has led to the invention of a new class of solar concentrators, the most well known version of which is the Compound Parabolic Concentrator or CPC. A new formalism for analyzing nonimaging systems in terms of a quantity called the geometrical vector flux has been developed. This has led not only to a better understanding of the properties of ideal concentrators but to the discovery of several new concentrator designs. One of these new designs referred to as the trumpet concentrator has several advantageous features when used as a secondary concentrator for a point focusing dish concentrator. A new concentrator solution for absorbers which must be separated from the reflector by a gap has been invented. The properties of a variety of new and previously known nonimaging optical configurations have been investigated: for example, Compound Elliptical Concentrators (CEC's) as secondary concentrators and asymmetric ideal concentrators. A thermodynamic model which explains quantitatively the enhancement of effective absorptance of gray body receivers through cavity effects has been developed. The classic method of Liu and Jordan, which allows one to predict the diffuse sunlight levels through correlation with the total and direct fraction was revised and updated and applied to predict the performance of nonimaging solar collectors. The conceptual design for an optimized solar collector which integrates the techniques of nonimaging concentration with evacuated tube collector technology was carried out and is presently the basis for a separately funded hardware development project.

27161 (IS-M—278) **Wind induced instability in salt gradient solar ponds.** Hull, J.R. (Ames Lab., IA (USA)). 1980. Contract W-7405-ENG-82. 5p. (CONF-800604—28). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

Observations of wind induced instability in the nonconvective zone (NCZ) of a small salt gradient solar pond are reported. The theory of stability for the NCZ is extended to include the case of an initial horizontal velocity distribution. For an initially stagnant fluid, perturbations occur as a complete set of decoupled normal modes. For the initial velocity distribution used here, each mode is coupled to at least one other mode, resulting in an infinite set of coupled equations to solve. An analytical solution is obtained by treating the stagnant fluid solution modes as fundamental, with the coupled modes as first order corrections. The resulting truncated determinant is solved for the characteristic equation. The conditions for stability are derived as a relationship between the salinity gradient, temperature gradient, and horizontal velocity. Numerical results are given for the lowest oscillation mode. Implications of these results on practical solar pond design are also discussed.

27162 (SAND—79-2006C) **Fluid temperature control for parabolic trough solar collectors.** Schindwolf, R. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 27p. (CONF-800805—2). NTIS, PC A03/MF A01.

From Joint automatic control conference: San Francisco, CA, USA (13 Aug 1980).

Techniques for controlling the temperature of the heat transfer fluid in parabolic trough solar collectors fields were studied by computer simulation. In particular, the rather stringent temperature control requirements associated with thermal electric power generation or cogeneration systems are addressed. Computer models representing the fluid temperature dynamics of the collectors and interconnecting piping were developed and integrated with dynamic models of control elements to obtain a closed loop control system simulation. A specific control configuration was chosen consisting of a flow control valve and one or more temperature sensors to control the flow in each row of collectors. Various control algorithms were

evaluated for stability and static errors, and time responses to startup transients and to partial and full collector cloud shadowing transients were obtained. The results indicated that the temperature control requirements can be satisfied using readily available components.

27163 (SAND—79-2134C) **Parabolic trough solar collector wind loading.** Randall, D.E.; McBride, D.D.; Tate, R.E. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 54p. (CONF-800804—16). NTIS, PC A04/MF A01.

From ASME century 2 emerging technology conference; San Francisco, CA, USA (10 Aug 1980).

Two wind tunnel force and moment tests have been conducted on parabolic trough solar collector configurations. The two tests were conducted in different flow field environments, one a uniform flow infinite airstream, the second a simulated atmospheric boundary layer flow with the models simulating a ground mounted installation. The force and moment characteristics of both isolated single module troughs and of trough modules within array configurations have been defined over both operational and stow attitudes. The influence of various geometric design parameters for collector modules and arrays has been established. Data indicate that forces and moments increase with mounting height and with trough aspect ratio. Collector modules interior to large arrays experience wind force reductions as high as 50 to 65%, while appropriate fences or berms surrounding the arrays can provide exterior modules with protection of this order.

27164 (SAND—79-7008) **Design and fabrication of combined photovoltaic-thermal collectors.** (ARCO Solar, Inc., Chatsworth, CA (USA)). May 1980. Contract AC04-76DP00789. 54p. NTIS, PC A04/MF A01.

ASI designed, fabricated and tested two water-cooled and two air-cooled modules under this program. Module designs were developed which effectively combined ASI photovoltaic cell and module technology with solar thermal module technology of Solaron and Solargenics, with minimum modification. The combined modules were designed to be mechanically interchangeable with production solar thermal modules. This design approach was selected to minimize installation and reliability problems, and to reduce costs of combined modules by minimizing new tooling requirements. Both the electrical and thermal performance of the experimental modules was lower than calculated during the design phase of the program, and lower than required by the Sandia specification. Test results were adequate to define problem areas and corrective design changes. As a result of design improvements occuring during the course of this program in both photovoltaic and thermal module technology, additional design changes are recommended to improve cost effectiveness. A second round of development is recommended before proceeding to production of combined modules. (WHK)

27165 (SAND—80-0865(Rev.)) **Line-focus solar thermal energy technology development FY 79 annual report for Department 4720.** Bergeron, K.D.; Champion, R.L.; Hunke, R.W. (eds.). (Sandia Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 139p. NTIS, PC A07/MF A01.

The primary role of the Solar Energy Projects Department II (4720) is the development, evaluation, and testing of line-focus solar thermal technology. This report of FY 1979 progress and accomplishments is divided into two parts: (1) Component and Subsystem Development including the design and analysis of collector modules, their components, and associated materials and processes; and (2) Systems and Applications Development, involving larger configurations of solar thermal line-focus systems. The emphasis is on parabolic troughs, but significant efforts on hemispherical bowls, compound parabolic collectors, and dishes for the Solar Total Energy Project are also described.

27166 (SAND—80-7023) **Mean wind forces on parabolic-trough solar collectors.** Peterka, J.A.; Sinau, J.M.; Cermak, J.E. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). May 1980. Contract AC04-76DP00789. 121p. NTIS, PC A06/MF A01.

The purpose of this study was to investigate characteristics of mean wind loads produced by airflow in and around several configurations of parabolic trough solar collectors with and without a wind fence. Four basic parabolic shapes were investigated as single units and one shape was studied as part of several array fields. One 1:25 scale model of each parabolic shape was constructed for mounting on a force balance to measure two forces and three moments. The effects of several dominant variables were investigated in this study: wind-azimuth (or yaw), trough elevation (or pitch) angle, array field configuration, and protective wind fence characteristics. All measurements were made in a boundary-layer flow developed by the meteorological wind tunnel at the Fluid Dynamics and Diffusion Laboratory of Colorado State University. Results are presented and discussed. (WHK)

27167 **Cost/performance goals for agricultural solar collectors.** Hellickson, M.A. (SD State Univ, Brookings). *ASAE Tech. Pap.;* 17(1979). (CONF-7906167—).

From ASAE and CSAE Canadian Society of Agricultural Engineering summer meeting; Winnipeg, Canada (24 Jun 1979).

A method for integrating solar collector performance characteristics, climatic conditions and economic parameters to determine economic feasibility is presented for multiple use agricultural solar collectors. Results are reported for a specific geographic location and solar drying and heating applications.

HEAT STORAGE

REFER ALSO TO CITATION(S) 27132, 27161

27168 (SAND—79-8198) **Chemical energy storage for solar thermal conversion. Final report.** Smith, R.D. (Rocket Research Co., Redmond, WA (USA)). 27 Apr 1979. Contract AC04-76DP00789. 99p. NTIS, PC A05/MF A01.

The technical and economic aspects of using reversible chemical reactions to store energy in Solar Thermal Electric Conversion (STEC) facilities have been studied. The study included identification of nine promising chemical reactions from a list of over 550 candidates, preliminary process designs of energy storage subsystems based on these nine reactions, and extensive systems studies of autonomous (100% solar) and hybrid (requiring alternate energy backup) STEC plants with energy storage subsystems based on the reversible oxidation of SO_2. Storage round-trip thermal efficiencies for the reactions studied ranged from 20 to 50%; power-related unit costs varied between 0.5×10^5 and 10×10^5 $/MW/sub t/ maximum storage charging rate; and energy-related unit costs varied between 0.5×10^3 and 24×10^3 $/MW/sub t/-hr storage capacity. Process designs based on the two reactions, $SO_2 + 1/2\ O_2 = SO_3$, and $CaO + H_2O = Ca(OH)_2$, are discussed in detail. The systems studies used a detailed simulation, based on a year-long, hour-by-hour energy balance, of a central-receiver STEC facility. Over a range of alternate energy cost and geographic location, the optimum busbar energy costs from autonomous STEC plants were 15 to 90% higher than those from hybrid plants. Optimum storage requirements of autonomous STEC plants were in the range of 200 to 400 hours, while those for hybrid plants were in the range of 15 to 30 hours.

GEOTHERMAL ENERGY

RESOURCE STATUS AND ASSESSMENT

USA

27169 (DOE/ET/28373—T2) **Geothermal resources of the eastern United States.** Renner, J.L.; Vaught, T.L. (Gruy Federal, Inc., Arlington, VA (USA)). Dec 1979. Contract ET-78-C-08-1558. 63p. NTIS, PC A04/MF A01.

Known and potential geothermal resources of the eastern United States are reported. The resources considered are exclusively hydrothermal, and the study was confined to the 35 states east of the Rocky Mountains, excluding the Dakotas. Resource definition in these areas is based entirely on data found in the literature and in the files of a number of state geological offices. The general geology of the eastern United States is outlined. Six relatively homogeneous eastern geologic regions are discussed. (MHR)

27170 (NVO—1558-8) **Preliminary definition of the geothermal resources potential of West Virginia.** Renner, J.L.; Vaught, T.L. (Gruy Federal, Inc., Arlington, VA (USA)). Jan 1979. Contract ET-78-C-08-1558. 27p. NTIS, PC A03/MF A01.

Most of West Virginia is underlain by Paleozoic sedimentary rocks. Crystalline rocks are limited to two areas: a small area in the Harpers Ferry region and some basic intrusives and extrusives in Pendleton County. In the Valley and Ridge province the rocks are folded and faulted. The deformation appears to be confined to the sediments overlying the crystalline basement. The Appalachian Basin is characterized by moderately dipping sediments which may reach ticknesses of 7600 meters (25,000 feet) in eastern West Virginia. The 38th parallel fracture zone may extend through West Virginia and serve to localize geothermal resources. Heat flow in West Virginia appears to be rather uniform and in the range of 1.12 to 1.26 heat flow units. Bottomhole temperatures from oil and gas tests show no abnormally hot spots. Warm springs are limited to the eastern portion of West Virginia in the folded Appalachians and appear to be located on the flanks of anticlines at topographic lows. Geothermometry suggests subsurface temperatures in the 45 to 65°C (113 to 149°F) range. The Appalachian Basin provides a thick sequence of rocks with normal geothermal gradient (18.2°C/kilome-

ter, 1°F/100 feet). High temperatures are expected at great depths, but production rates are likely to be low. Several oil and gas tests in West Virginia have encountered pressures about twice the normal pressure expected at the depth. However, the overpressured zones appear to be of small extent.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

REFER ALSO TO CITATION(S) 26895, 27169

GEOPHYSICAL TECHNIQUES AND SURVEYS

27171 (LBL—9549) **Resistivity monitoring at Cerro Prieto.** Wilt, M.J.; Goldstein, N.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1980. Contract W-7405-ENG-48. 12p. (CONF-7910166—4). NTIS, PC A02/MF A01.

From 2. symposium on the Cerro Prieto Geothermal Field; Baja California, Mexico (17 Oct 1979).

In 1978 Lawrence Berkeley Laboratory, in cooperation with Comision Federal de Electricidad, began a program of dipole-dipole resistivity monitoring at the Cerro Prieto geothermal field. Dipole-dipole measurements were first made in 1978, then repeated in 1979: (a) to determine whether the field boundaries could be defined by surface resistivity measurements; and (b) to determine if changes in reservoir conditions due to production may be monitored by surface measurements. In 1979 data accuracy was improved to where estimated measurement errors were less than 3%. In addition, data coverage on a line over the field was expanded by 40% for greater depth of investigation and more information on the newer, eastern part of the field. Resistivity modeling of the expanded 1979 profile indicates that the resistive body associated with the zone of production (Wilt et al., 1978) dips steeply eastward, and may underlie the eastern part of the field. The model also shows a thin steeply dipping conductor adjacent to the resistive body that may be associated with faulting and fluid movement. Model perturbation studies have shown that small changes associated with cold-water influx, fault zone migrations, and formation of a steam zone would all be detectable with precision dipole-dipole measurements. Telluric profile measurements taken along line E-E' were found to yield a significant amount of reconnaissance information but are unsuitable for monitoring purposes.

27172 (LBL—9550) **Earthquake monitoring at the Cerro Prieto geothermal field.** Majer, E.L.; McEvilly, T.V. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA)). Feb 1980. Contract W-7405-ENG-48. 6p. (CONF-7910166—3). NTIS, PC A02/MF A01.

From 2. symposium on the Cerro Prieto Geothermal Field; Baja California, Mexico (17 Oct 1979).

A three-week study in spring 1978 revealed more moderate earthquake activity (one or two events/day, M/sub L/ $\geqq$ 1) in the Cerro Prieto production zone. Plotting these events on a Wadati diagram we estimated an 0.4 Poisson's ratio for the upper 1 to 2 km of the field. The events were centered near the western edge of the production zone, near well M-6, and indicated strikeslip movement on north-south faults. To monitor the earthquake activity and propagation characteristics within the production zone, a five-station, semi-permanent array was put into operation in September 1979. The stations are closely spaced (1 to 2 km), surrounding a central station at M-6. Each station consists of a three-component 4.5-Hz geophone in a 100-m well connected to a 12-bit triggered-digital-cassette recorder. Although each station operates independently, they are interconnected via a hard-wire link to a central site. The purpose of this link is twofold: first, to allow telemetry of any selected station to the central site for visual monitoring; second, to provide an automatic daily time calibration to keep inter-station errors to less than 5 ms. The data from these stations will be used to monitor earthquake activity and wave propagation characteristics associated with fluid withdrawal and/or injection in the geothermal reservoir.

EXPLORATORY DRILLING AND WELL LOGGING

27173 (DOE/ET/28405—1) **Geothermal reservoir assessment: Cove Fort-Sulphurdale Unit. Final report, September 1977-July 1979.** Ash, D.L.; Dondanville, R.F.; Gulati, M.S. (Union Oil Co. of California, Los Angeles (USA). Geothermal Div.). Dec 1979. Contract AC08-77ET28405. 38p. NTIS, PC A03/MF A01.

Three exploratory geothermal wells were drilled in the Cove Fort-Sulphurdale geothermal resource area in southwestern Utah to obtain new subsurface data for inclusion in the US DOE's geothermal reservoir assessment program. Existing data from prior investigations which included the drilling of an earlier exploratory well at the Cove Fort-Sulphurdale area was also provided. Two of the wells were abandoned before reaching target depth because of severe lost circulation and hole sloughing problems. The two completed holes reached depths of 5221 ft. and 7735 ft , respectively, and a maximum reservoir temperature of 353°F at 7320 ft. was measured. The deepest well flow was tested at the rate of 47,000 lbs/h with a wellhead temperature of 200°F and pressure of 3 psig. Based upon current economics, the Cove Fort-Sulphurdale geothermal resource is considered to be sub-commercial for the generation of electrical power. A synopsis is given of the exploratory drilling activities and results containing summary drilling, testing, geologic and geochemical information from four exploratory geothermal wells.

27174 (LA-UR—80-70) **Calibration models for fractured rock environments.** Mathews, M. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 7p. (CONF-800711—3). NTIS, PC A02/MF A01.

From 21. annual logging symposium; Lafayette, LA, USA (8 Jul 1980).

Accurate measurement and recording of log data is necessary for effective well evaluation, reservoir engineering assessment, and subsurface geological or geophysical appraisal. Proper interpretation of log data provides accurate subsurface geologic parameters. Calibration data that is auxiliary to the log data will show the degree of log accuracy and indicate the reliability of the estimated subsurface geologic parameters when the log data is reviewed with a knowedge of the calibration procedures. Three large calibration models or test pits are presently being fabricated. Each calibration model will be constructed of large stone blocks which have a cored-borehole and wire-sawn simulated fractures. Details of the test pits size, simulated fracture locations, rock type of each test pit, and location and access of these pits are discussed. Supporting data from rock properties of similar rock that will be used in each test pit are included.

27175 (LA-UR—80-772) **Transmission of acoustic signals through hydraulic fractures.** Albright, J.N.; Pearson, C.F.; Fehler, M.C. (Los Alamos Scientific Lab., NM (USA); Oregon State Univ., Corvallis (USA)). 1980. Contract W-7405-ENG-36. 20p. (CONF-800711—2). NTIS, PC A02/MF A01.

From 21. annual logging symposium; Lafayette, LA, USA (8 Jul 1980).

Acoustic signals transmitted between wells have been used to study the structure of the hot dry rock geothermal reservoir at Fenton Hill, New Mexico. The signals produced, usign commercially available logging tools, traveled paths as long as 45.7 m (150 ft) in fractured granitic basement rock. Both P- and S-waves were transmitted, the amplitude of the latter varying with the inclination between logging positions in each well. On pressurization of the reservoir, the signals showed changes in attenuation and waveform. The change in attenuation varied from a value of -2 dB above the fractured portion of the reservoir to -30 dB near the fracture wellbore intersections. The signals, having amplitude content in the frequency range from 6 to 16 kilohertz, were severely attenuated in the higher frequencies. Signal waveforms were limited to one of three distinctive types - the first having a pronounced S-wave arrival, the other two having either no S-wave arrival or apparent distributed P- and S-wave arrivals. The general character of each waveform seems to depend on the absence or presence of fractures along the signal travel paths, on the multiplicity of fractures, and on their pressure states. The propagation velocity of the signals did not change perceptibly on reservoir pressurization. However, the velocity did change as much as 6% locally in the reservoir following a prolonged period of heat extraction and pressure cycling, resulting in extensive microfracturing of the bulk rock.

ECONOMIC AND FINANCIAL ASPECTS

27176 (CONF-800525—4) **Evaluation of the geopressured energy resource of Louisiana and Texas.** Samuels, G. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 18p. NTIS, PC A02/MF A01.

From SPE/DOE symposium on unconventional gas recovery; Pittsburgh, PA, USA (18 May 1980).

The economics of extracting either the geothermal energy or natural gas from geopressured aquifers does not look promising. The combined requirements of high well flow rates, long life, and the necessity for close well spacing to minimize the cost of the collection system may be incompatible with the actual characteristics of the reservoirs. These factors place such stringent requirements on the reservoir size, permeability and compressibility that the number of promising production areas may be severely limited.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

REFER ALSO TO CITATION(S) 27172, 27885, 27915, 27958, 27959, 27960, 28002

27177 (LBL—10838) **Physical processes of compaction companion report 1 to simulation of geothermal subsidence.** Miller, I.;

Dershowitz, W.; Jones, K.; Myer, L.; Roman, K.; Schauer, M. (Golder Associates, Inc., Kirkland, WA (USA)). Mar 1980. Contract W-7405-ENG-48. 41p. (GSRMP—7). NTIS, PC A03/MF A01.

There are a variety of theories, techniques, and parameters in the subsidence literature. Biot's theory, Terzaghi's theory, and the theory of interacting continua (TINC) are used to explain solid-fluid interaction; stress-strain theories range from linear elastic to e-log p to plasticity and pore-collapse theories. Parameters are numerous: void ratio,, permeability, compaction coefficient, pore compressibility, Young's modulus, bulk modulus, shear modulus, Poisson's ratio, Lame coefficients, coefficient of consolidation, and storage coefficient. The physical processes which govern compaction and deformation in geothermal systems are reviewed. The review is an attempt to provide a reasonably coherent general structure for the theories and parameters which were referred to above. The materials presented is a compendium of existing published work.

GEOTHERMAL POWER PLANTS

DESIGN AND OPERATION

27178 (CONF-800806—8) **Raft River 5-MW(e) geothermal pilot plant.** Stiger, R.R. (EG and G Idaho, Inc., Idaho Falls (USA)). 1980. Contract AC07-76ID01570. 4p. NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

A 5-MW(e) binary cycle pilot plant which is being built in the Raft River valley in Idaho will employ a dual boiling power cycle using isobutane as the working fluid. It is designed to take maximum advantage of the low average seasonal temperatures and will contain sufficient instrumentation and data acquisition equipment to obtain accurate performance data. In addition, some of the large heat exchangers will contain special instrumentation to obtain details of their performance. Design was completed on this facility in January 1978, construction started in August 1978, and plant startup and operation are scheduled for October 1980. A detailed description of the 5-MW(e) facility is provided. (MHR)

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

REFER ALSO TO CITATION(S) 27173

27179 (SAND—79-2397) **Geothermal drilling ad completion technology development program. Semi-annual progress report, April-September 1979.** Varnado, S.G. (ed.). (Sandia Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 222p. NTIS, PC A10/MF A01.

The progress, status, and results of ongoing Research and Development (R and D) within the Geothermal Drilling and Completion Technology Development Program are described. The program emphasizes the development of geothermal drilling hardware, drilling fluids, and completion technology. Advanced drilling systems are also under development. The goals of the program are to develop the technology required to reduce well costs by 25% by 1982 and by 50% by 1986.

27180 (SAND—80-7079) **Field drilling tests on improved geothermal unsealed roller-cone bits. Final report.** Hendrickson, R.R.; Jones, A.H.; Winzenried, R.W.; Maish, A.B. (Terra Tek, Inc., Salt Lake City, UT (USA)). May 1980. Contract AC04-76DP00789. 109p. NTIS, PC A06/MF A01.

The development and field testing of a 222 mm (8-3/4 inch) unsealed, insert type, medium hard formation, high-temperature bit are described. Increased performance was gained by substituting improved materials in critical bit components. These materials were selected on bases of their high temperature properties, machinability and heat treatment response. Program objectives required that both machining and heat treating could be accomplished with existing rock bit production equipment. Six of the experimental bits were subjected to air drilling at 240°C (460°F) in Franciscan graywacke at the Geysers (California). Performances compared directly to conventional bits indicate that in-gage drilling time was increased by 70%. All bits at the Geysers are subjected to reaming out-of-gage hole prior to drilling. Under these conditions the experimental bits showed a 30% increase in usable hole drilled, compared with the conventional bits. The materials selected improved roller wear by 200%, friction per wear by 150%, and lug wear by 150%. These tests indicate a potential well cost savings of 4 to 8%. Savings of 12% are considered possible with drilling procedures optimized for the experimental bits.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

REFER ALSO TO CITATION(S) 26892

27181 (CONF-800629—2) **Low-temperature hydrothermal resource evaluation.** Goldman, D. (EG and G Idaho, Inc., Idaho Falls (USA)). 1980. Contract AC07-76ID01570. 2p. NTIS, PC A02/MF A01.

From Symposium on commercial uses of geothermal energy; Boise, ID, USA (16 Jun 1980).

The objectives of testing low-temperature hydrothermal wells are to characterize well response to production (injection), determine resource characteristics and project reservoir longevity. Testing procedures and analysis techniques differ in some respects from proven procedures in the oil and gas and ground water fields. Some basic definitions and standard techniques necessary for the evaluation of a fluid resource in an intergranular permeable reservoir are presented. Problems particular to a non-ideal thermal resource are outlined and some analytical techniques are discussed.

27182 (DOE/ET/27225—5) **Prediction of the entropy production and pressure losses in two-phase flow from the mixing length theory.** Maeder, P.F.; Michaelides, E.E. (Brown Univ., Providence, RI (USA). Div. of Engineering). Apr 1980. Contract AC02-79ET27225. 54p. NTIS, PC A04/MF A01.

The case of vertical two-phase flow is examined under the light of the mixing-length theory which was succesfully applied to turbulent flows. The purpose of the analysis is to obtain the pressure distribution along the geothermal wells. The well is modeled as a vertical pipe carrying a fluid of variable density; the density distribution is described by two parameters. The conservation equations are written in boundary layer coordinates and the pressure losses are computed through the entropy production function. The two-phase friction factor is defined and calculated and through this the pressure distribution of the geothermal well is obtained. Finally a comparison is made of the results emanating from this model to other theoretical predictions and known experimental data.

27183 (LBL—10562) **Transient well testing in two-phase geothermal reservoirs.** Aydelotte, S.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 148p. (GREMP—8). NTIS, PC A07/MF A01.

A study of well test analysis techniques in two-phase geothermal reservoirs has been conducted using a three-dimensional, two-phase, wellbore and reservoir simulation model. Well tests from Cerro Prieto and the Hawaiian Geothermal project have been history matched. Using these well tests as a base, the influence of reservoir permeability, porosity, thickness, and heat capacity, along with flow rate and fracturing were studied. Single and two-phase transient well test equations were used to analyze these tests with poor results due to rapidly changing fluid properties and inability to calculate the flowing steam saturation in the reservoir. The injection of cold water into the reservoir does give good data from which formation properties can be calculated.

DIRECT ENERGY UTILIZATION

27184 (DOE/ET/27232—T1) **Utilization of geothermal energy in the mining and processing of tungsten ore. Quarterly report.** Lane, C.K.; Erickson, M.V.; Lowe, G.D. (WESTEC Services, Inc., San Diego, CA (USA)). 1980. Contract AC03-79ET27232. 61p. NTIS, PC A04/MF A01.

The status of the engineering and economic feasibility study of utilizing geothermal energy for the mining and processing of tungsten ore at the Union Carbide-Metals Division Pine Creek tungsten complex near Bishop, Calfironia is reviewed. Results of geophysical data analysis including determination of assumed resource parameters are presented. The energy utilization evaluation identifies potential locations for substituting geothermal energy for fossil fuel energy using current technology. Preliminary analyses for local environmental and institutional barriers to development of a geothermal system are also provided.

27185 (JPL-PUB—80-41) **Geothermal direct heat use: market potential/penetration analysis for Federal Region IX (Arizona, California, Hawaii, Nevada).** Powell, W.; Tang, K. (eds.). (Jet Propulsion Lab., Pasadena, CA (USA)). May 1980. Contract AI03-79ET37116. 328p. NTIS, PC A15/MF A01.

A preliminary study was made of the potential for geothermal direct heat use in Arizona, California, Hawaii, and Nevada (Federal Region IX). The analysis for each state was performed by a different team, located in that state. For each state, the study team was asked to: (1) define the resource, based on the latest available data; (2) assess the potential market growth for geothermal energy; and (3) estimate the market penetration, projected to 2020. Each of the four states of interest in this study is unique in its own way. Rather than impose the same assumptions as to growth rates, capture rates, etc.

on all of the study teams, each team was asked to use the most appropriate set of assumptions for its state. The results, therefore, should reflect the currently accepted views within each state. The four state reports comprise the main portion of this document. A brief regional overview section was prepared by the Jet Propulsion Laboratory, following completion of the state reports.

WIND ENERGY

AVAILABILITY (CLIMATOLOGY)

27186 (PNL—3138) **Definition of gust model concepts and review of gust models.** Powell, D.C.; Connell, J.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76RL01830. 100p. NTIS, PC A05/MF A01.

Four models are examined which attempt to describe wind fluctuations in relation to a wind energy conversion system (WECS) that is subjected to these fluctuations observed from a fixed location within the atmospheric boundary layer. The primary purpose of this examination is to provide a basis for understanding present and future developments in gust and gust-rise models. The examination is accomplished by identifying the gust definitions used in the models and relating them to a basic definition given.

27187 (PNL—3211) **Annual report of the Wind Characteristics Program Element, July 1978-September 1979.** Wendell, L.L.; Barchet, W.R.; Connell, J.R.; Miller, A.H.; Pennell, W.T.; Renne, D.S. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1980. Contract AC06-76RL01830. 209p. NTIS, PC A10/MF A01.

As a service element within the Federal Wind Energy Program, the Wind Characteristics Program Element (WCPE) is established to provide the appropriate wind characteristics information to those involved in: the design and evaluation of wind energy conversion systems (WECS); energy program planning; selecting sites for WECS installation; and the operation of WECS. To effectively produce the information needed in these four categories, the WCPE, for which the Pacific Northwest Laboratory (PNL) has the responsibility for management and technical assistance, has been divided into four technical program areas. During this reporting period PNL was also assigned the management responsibility for the data collection at the US Department of Energy's (DOE's) candidate sites, as well as the task of providing technical assistance to DOE evaluation and site selection panels for new candidate sites.

ECONOMICS

27188 (RFP—3087) **SWECS qualifications criteria for state tax incentive program.** Guerrero, J.V.; Alford, C. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1980. Contract AC04-76DP03533. 9p. (CONF-800406—7). NTIS, PC A02/MF A01.

From Wind energy conference; Boulder, CO, USA (9 Apr 1980).

Alternative energy systems will play a significant role in providing energy supplies to the United States; estimates range from 7 to 23 percent of the nation's needs by 2000. Small Wind Energy Conversion Systems (SWECS) together with large wind turbine generators will supply a portion of these energy supplies. The level of disbursed SWECS contribution will depend not only on resolving technical problems but the resolution of institutional issues as well. One of the major institutional barriers is the high initial cost of SWECS compared to conventional energy costs. State and federal financial incentive programs such as income tax deductions and credits can promote public acceptance of SWECS. Several prototype qualification documents are being prepared by the Rockwell International Wind Systems Program at Rocky Flats, Colorado (under contract to the Department of Energy) to guide the states in formulating their own specific set of criteria that would be most appropriate for their own situation.

27189 (SERI/TP—351-545) **Planning for electric utility solar applications: the effects on reliability and production cost estimates of the variability in demand.** Fegan, G.R.; Percival, C.D. (Solar Energy Research Inst., Golden, CO (USA)). Jan 1980. Contract AC02-76CH00178. 14p. (CONF-800804—18). NTIS, PC A02/MF A01.

From ASME century 2 emerging technology conference; San Francisco, CA, USA (10 Aug 1980).

Previous studies have shown the necessity of the consideration of hourly variability in the output from the intermittent generation source. However, the studies did not take into account the variability in the demand. A result is presented which shows that under general conditions the variability due to randomness can be ignored except in the neighborhood of the peak and minimum demands.

27190 (SERI/TR—98298-1) **Capital formation for small wind energy conversion system manufacturers: a guide to methods and sources. Final report.** Smeallie, P.H.; Wolff, B. (American Wind Energy Association, Washington, DC; Vonier (Thomas) Associates, Inc., Washington, DC (USA)). May 1980. Contract EG-77-C-01-4042. 55p. NTIS, PC A04/MF A01.

A workshop of wind machine manufacturers and financial experts contributed to the development of this guide to capital formation. Sources of capital are described and the development of a business plan explained. The report includes case histories of four wind companies' experiences in raising capital.

WIND ENERGY ENGINEERING

TURBINE DESIGN AND OPERATION

27191 (DOE/NASA/3277—1) **Feasibilty study of aileron and spoiler control systems for large horizontal axis wind turbines.** Wentz, W.H. Jr.; Snyder, M.H.; Calhoun, J.T. (Wichita State Univ., KS (USA)). May 1980. Contract AI01-76ET20320. 69p. (NASA-CR—159856). NTIS, PC A04/MF A01.

Studies have been conducted to determine the feasibility of using aileron or spoiler controls as alternates to pitch control for large horizontal axis wind turbines. The NASA Mod-0 100 kw machine was used as the basis for this study. Specific performance studies were conducted for 20% chord ailerons over the outboard 30% span, and for 10% chord spoilers over the same portion of the span. Both control systems utilized control deflections up to 60°. Results of the study show that either ailerons or spoilers can provide the control necessary to limit turbine power in high wind conditions. The aileron system, as designed, provides overspeed protection at hurricane wind speeds, low wind speed starting torque of 778 N-m at 3.6 m/s, and a 1.3 to 1.5% increase in annual energy compared to a fixed pitch rotor.

27192 (RFP—3085) **UTRC 8 kW wind turbine tests.** Cheney, M.C. (United Technologies Research Center, East Hartford, CT (USA)). 1980. Contract AC04-76DP03533. 9p. (CONF-800406—5). NTIS, PC A02/MF A01.

From Wind energy conference; Boulder, CO, USA (9 Apr 1980).

The United Technologies Research Center (UTRC) 8 kW prototype wind turbine became operational in July 1979 and underwent testing in East Hartford, CT until delivery to Rockwell International, the prime contractor, in February 1980. The program will continue with the field evaluation by Rockwell at their Rocky Flats site during 1980. The prototype testing demonstrated the basic operation of the unique control concept of the UTRC Composite Bearingless Wind Turbine which utilizes a hub-mounted pendulum employed to twist the graphite composite inboard region of the blade producing blade pitch variations. The tests also demonstrated the predicted performance of 9 kW at 20 mph, and the high speed stall control feature.

27193 (RFP—3086) **Field Evaluation Program for small wind energy conversion systems.** Alexander, J.H. (United Technologies Research Center, East Hartford, CT (USA)). 1980. Contract AC04-76DP03533. 2p. (CONF-800406—6). NTIS, PC A02/MF A01.

From Wind energy conference; Boulder, CO, USA (9 Apr 1980).

The Field Evaluation Program (FEP) solicits the cooperation of State Energy Offices (SEO) to undertake the selection of users and the siting of approximately 120 Small Wind Energy Conversion Systems (SWECS), in cooperation with electric utilities, throughout most of the fifty states and six territories of the US SWECS rated within the two to forty kW range will be purchased from about twelve manufacturers. These SWECS will be interconnected to a utility line. Data will be collected at each site on the load profile, energy output of SWECS, the technical and institutional procedures for siting and installation, available wind energy, and performance and failure modes of the SWECS. The program status as of mid-February 1980 is reviewed.

27194 (SAND—80-1155) **User's manual for the vertical axis wind turbine performance computer code darter.** Klimas, P.C.; French, R.E. (Sandia Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 48p. NTIS, PC A03/MF A01.

The computer code DARTER (DARrieus, Turbine, Elemental Reynolds number) is an aerodynamic performance/loads prediction scheme based upon the conservation of momentum principle. It is the latest evolution in a sequence which began with a model developed by Templin of NRC, Canada and progressed through the Sandia National Laboratories-developed SIMOSS (sSImple MO-

mentum, Single Streamtube) and DART (SARrieus Turbine) to DARTER.

SITE CHARACTERISTICS

REFER ALSO TO CITATION(S) 27187

ELECTRIC POWER ENGINEERING

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 26776, 27339

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

27195 Bacterial aerosols produced from a cooling tower using wastewater effluent. Adams, A.P.; Garbett, M.; Rees, H.B.; Lewis, B.G. *J. Water Pollut. Control Fed.;* **52**: No. 3, 498-501(Mar 1980).

A cooling tower, which receives make-up water from a municipal wastewater treatment plant, was studied. Wastewater effluent was super-chlorinated, then treated with lime and a commercial coagulant to remove phosphates, calcium, magnesium, and suspended solids before it was pumped into the cooling tower. The chlorination and coagulation described above were used to reduce deposition of scale and slime on the power plant condenser surfaces. Bacterial counts were made of the cooling tower basin waters and of the aerosols exiting the cooling tower vents. It was dicovered that 39% of bacteria exiting the cooling tower vents were of the genus Pseudomonas. A few pathogenic microbes were also found to be present in the aerosolized particles but their numbers were so low that they were considered insignificant.

POWER CYCLES

REFER ALSO TO CITATION(S) 27137, 27138, 27139, 27291

27196 (FE—2291-44A) High temperature turbine technology program. Phase II. Technology test and support studies. Technical progress report, January 1, 1979-March 31, 1979. (Curtiss-Wright Corp., Wood-Ridge, NJ (USA). Power Systems Div.). Apr 1979. Contract EX-76-C-01-2291. 140p. (CW-WR—76-020-44A). NTIS, PC A07/MF A01.

Work performed on the High Temperature Turbine Technology Program, Phase II - Technology Test and Support Studies during the period from 1 January 1979 through 31 March 1979 is summarized. Objectives of the program elements as well as technical progress and problems during this Phase II quarterly reporting period are presented. Planned progress during the next quarterly reporting period is also defined. Progress on design, fabrication and checkout of test facilities and test rigs is described. The LP engine test program through 3000°F turbine inlet temperature is discussed. Design and analysis of the TSTR engine and synthesized low Btu gas components are discussed. Supporting materials and process investigations are reviewed.

COMPONENTS

REFER ALSO TO CITATION(S) 26767, 26823, 26824, 26825, 26827, 27196, 27621

27197 (BNL—51108) Nature and utility of some unsteady characteristics of a fossil-fuel-fired boiler. Berlad, A.L. (Brookhaven National Lab., Upton, NY (USA)). Jan 1980. Contract AC02-76CH00016. 12p. NTIS, PC A02/MF A01.

The dimensionless temperature rise rate of an initially cold fossil-fuel-fired boiler and the boiler's off-cycle cooling rate are examined analytically. If the thermal relaxation times for the non-water-containing boiler elements are to be relatively short, simplified expressions are found for the time variation of the dimensionless boiler temperature. The utility of these analytic results is examined in the light of experimental observations.

27198 (CONF-7906157—, pp 94-117) General Electric CFCC pressurized fluidized bed combined cycle power generation system. Thoennes, C.M. (General Electric Co., Schenectady, NY). Apr 1980.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

The Pressurized Fluidized Bed Combustor/Combined Cycle concept offers the potential for improved cycle efficiency and cost of electricity when compared to current pulverized coal-fired steam plants. Pressurized Fluidized Bed Combustor development testing has confirmed that high combustion efficiency (99%), sulfur removal of 85% or more at moderate Ca/S mole ratios, and NO/sub x/ emissions well below anticipated regulations are achievable at typical plant design operating conditions. As a result of the accumulated data in PFB process development testing, ongoing activities in hot gas clean-up and gas turbine materials development, the reference commercial plant design activity, and the completed design review, a comprehensive PFB Development Plan has been prepared. This plan includes recommendations for the establishment of key technology results followed by a prototype plant demonstration (if justified by the technology). The plan is intended to bring the PFB Combined Cycle Power Plant to readiness for commercial power generation at the earliest practical time. The recommended technology development required for early commercialization of the PFB technology includes three essential levels of experimental development: (1) small scale boiler and gas turbine materials testing in PFB environments for very long periods of time (typically 10,000 hours); (2) continued engineering scale process development testing; (3) large scale component testing of the combustor/steam generator, hot gas clean-up, and a heavy duty gas turbine.

27199 (DOE/ET/15207—T1) Design and development of Stirling engines for stationary power generation applications in the 500 to 3000 horsepower range. First quarterly report. (Advanced Mechanical Technology, Inc., Newton, MA (USA)). 7 Jan 1980. Contract AC02-79ET15207. 98p. NTIS, PC A05/MF A01.

This project is Phase I of a multi-phased program for the design and development of Stirling engines for stationary power generation applications in the 500 to 3000 horsepower range. Phase I comprises the conceptual design and associated cost estimates of a stationary Stirling engine capable of being fueled by a variety of heat sources, with emphasis on coal firing, followed by the preparation of a plan for implementing the design, fabrication and testing of a demonstration engine by 1985. The main effort in Phase I is the generation of state-of-the-art conceptual designs having greatest potential for prototype testing in 1985, along with advanced conceptual designs based on new technologies which may require significant R and D for commercialization. The conceptual designs include a heat transport system for integrating the engine heater head with such energy sources as conventional oil/gas combustors, fluidized bed and other coal combustors, and combustors using coal-derived liquid fuels, and low/medium Btu gases.

27200 (DOE/NASA/2593—16) Evaluation of hot corrosion behavior of thermal barrier coatings. Hodge, P.E.; Miller, R.A.; Gedwill, M.A. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1980. Contract AI01-77ET10350. 12p. (NASA-TM—81520; CONF-800439—8). NTIS, PC A02/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (21 Apr 1980).

Calcium silicate and yttria-stabilized zirconia/MCrAlY thermal barrier coating systems on air-cooled specimens were exposed to sodium plus vanadium doped Mach 0.3 combustion gases. Thermal barrier coating endurance was determined to be a strong inverse function of ceramic coating thickness. Coating system durability was increased throuh the use of higher Cr + Al NiCrAl and CoCrAlY bond coatings. Chemical and electron micrprobe analyses supported the predictions of condensate compositions and the determination of their roles in causing spalling of the ceramic coatings.

27201 (FE—1726-22A) Engineer, design, construct, test and evaluate a pressurized fluidized bed pilot plant using high sulfur coal for production of electric power. Phase I. Preliminary engineering. Topical report, 1 March 1976-1 June 1977. Moskowitz, S.; Cole, R.; Defeo, A. (Curtiss-Wright Corp., Wood-Ridge, NJ (USA). Power Systems Div.). Jun 1977. Contract AC01-76ET10417. 97p. (CW-WR—76-015.22A). NTIS, PC A05/MF A01.

A promising approach for clean, cost-competitive, electric power generation from coal with improved power cycle efficiency involves the application of a pressurized fluidized bed (PFB) combustor to a combined cycle. Based on a conceptual design of a 500 MW base load power station, a configuration for a pilot electric plant was selected which will use high sulfur (> 31%) coal in the presence of a sulfur sorbent (dolomite) material. The gas turbine in this system provides one-third of its compressor airflow to the fluidized bed for coal combustion and the balance of flow to the in-bed heat exchanger. The pilot plant will have the capacity for generating an equivalent of 13 MW. The gas turbine provides over 7 MW of electric power and the steam generated by the waste heat recovery boiler is 58,000 lb/hour. The plant equipment is over 40 percent of the physical size of the commercial plant design. The pilot plant will be a conversion of an existing Total Energy System located at the Wood-Ridge, New Jersey manufacturing facility of

Curtiss-Wright. This report describes the plant arrangement, the equipment design configuration, and plant performance.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 27140, 27364, 27369

ECONOMICS

REFER ALSO TO CITATION(S) 27140, 27284, 27285, 27286, 27287

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 27049, 27253

27202 (DOE/NASA/0806—79/1) **High-temperature molten salt thermal energy storage systems.** Petri, R.J.; Claar, T.D.; Tison, R.R. (Institute of Gas Technology, Chicago, IL (USA)). Feb 1980. Contract AI01-77ET26945. 176p. (NASA-CR—159663). NTIS, PC A09/MF A01.

Experimental results of comparative screening studies of candidate molten carbonate salts as phase-change materials (PCM) for advanced solar-thermal energy storage applications at 540° to 870°C and steam-Rankine electric generation at 400° to 540°C are presented. Alkali carbonates are attractive as latent-heat storage materials because of their relatively high storage capacity and thermal conductivity, low corrosivity, moderate cost, and safe and simple handling requirements. Salts were tested in 0.1 kWhr lab-scale modules and evaluated on the basis of discharge heat flux, solidification temperature range, thermal cycling stability, and compatibility with containment materials. The feasibility of using a distributed network of high-conductivity material to increase the heat flux through the layer of solidified salt was experimentally evaluated. The thermal performance of an 8 kWhr thermal energy storage (TES) module containing $LiKCO_3$ remained very stable throughout 5650 h and 130 charge/discharge cycles at 480° to 535°C. A TES utilization concept of an electrical generation peaking subsytem composed of a multistage condensing steam turbine and a TES subsystem with a separate power conversion loop was defined. Conceptual designs for a 100 MW/sub e/ TES peaking system providing steam at 316°, 427°, and 454° at 3.79 x 10^6 Pa were developed and evaluated. Areas requiring further investigation have also been identiied.

FUELS

27203 (EPRI-EL—1319) **Long-term, mid-term, and short-term fuel scheduling.** Seymore, G.E. (Boeing Computer Services Co., Seattle, WA (USA). Energy Technology Applications Div.). Jan 1980. 139p. NTIS, PC A07/MF A01.

Since 1973, electrical utilities have gained a sharply increased awareness of the impact of fuel prices and fuel availabilities on their operations and performance. The remarkable increase in oil and gas prices, the ever-present threat of an oil embargo, and the coal strike of 1978 all highlight the instability of the current fuel supply situation. Moreover, one sees little hope of an appreciable near-term or long-term improvement. This study was undertaken to determine practical approaches by which utilities might incorporate the economics of the fuels market into their operational planning, scheduling and dispatching processes. The objective of Phase 1 was not to develop digital computer programs, but rather to determine the mathematical approaches that seem most promising. The computer program development will be done in later phases of the project. A substantial literature search and industry survey were performed. Fuel contract management was found to be of key importance, and the inherent uncertainty in the basic data (heat rate curves, fuel costs, etc.) suggested the use of simplified formulations and solution techniques. The yearly fuel planning problem and the weekly fuel scheduling problems are cast as linear network flow optimization problems, for which very efficient digital computer programs are available.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 27213, 27667, 27671, 28002

THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 27664

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

27204 (BNL—27505) **Generic analysis of the good engineering practice (GEP) stack height and prevention of significant deterioration (PSD) regulations for new power plants.** Lipfert, F.W. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 8p. (CONF-800327—11). NTIS, PC A02/MF A01.

From 2. joint conference on applications of air pollution meteorology; New Orleans, LA, USA (24 Mar 1980).

Portions of document are illegible.

All US fossil-fueled power plants coming on-line after 1977 must meet standards for the prevention of significant deterioration of air quality as set forth in the 1977 Clean Air Act Amendments. An analysis of the short-term, 24 h or less, air quality impact of stack-disposed effluents from proposed power plants is presented. Closed form solutions to the Gaussian plume equation are developed for worst case meteorology for 3-h and 24-h situations. The modeling technique uses a universal relationship for stack height based on good engineering practice requirements and shows that the resulting ground level concentrations are virtually independent of power plant size, within the meteorological constraints. The important parameters, then, become terrain elevation and degree of pollution control. The use of worst case meteorology obviates the need for a detailed meteorological data base. It is necessary only to check that the worst case conditions are in fact reasonable for the location in question, a site-specific consideration.

27205 (DOE/EV—0079) **Environmental control technology for atmospheric carbon dioxide. Final report.** Albanese, A.S.; Steinberg, M. (Brookhaven National Lab., Upton, NY (USA)). May 1980. Contract AC02-76CH00016. 30p. NTIS, PC A03/MF A01.

The impact of fossil fuel use in the US on worldwide CO_2 emissions and the impact of increased coal utilization on CO_2 emission rates are assessed. The aspects of CO_2 control are discussed as well as the available CO_2 removal sites. The primary factor affecting the practicability of a CO_2 control system is its energy requirements. Of the three potential CO_2 control points, removal from the stacks of fossil fuel power plants appears to require the least amount of energy. Estimates of the energy required to capture and recover CO_2 from coal-fired power plant stacks by various processes are presented. Although capture and recovery of CO_2 is an important consideration in the overall scheme of CO_2 control, disposal or reuse of recovered CO_2 may be the weakest link in the CO_2 control chain. Of the several options considered, deep ocean storage appears to be the most promising. Two control scenarios are evaluated, one based on the absorption of CO_2 contained in power plant flue gas by seawater; the other, based on absorption of CO_2 by monoethanolamine (MEA). Captured CO_2 is injected into the deep ocean in both cases. Our analyses indicate that capture and disposal by seawater is not feasible, whereas capture and disposal using MEA is a possibility. However, the economic penalties of CO_2 control are significant; for example, at a CO_2 removal efficiency of 50%, the power generation efficiency of a conventional coal fired power plant would be reduced from 34% to about 25%, and the cost of power generation would be expected to double. For 90% CO_2 removal, power generation efficiency is reduced to between 15 and 6% and the cost of power generation increases by a factor of from 4 to 7.

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 27283, 27288

27206 (DOE/RA/3022—01) **Optimization of distribution transformer efficiency characteristics. Final report, March 1979.** (Westinghouse Electric Corp., Pittsburgh, PA (USA)). Jun 1980. Contract AC01-78ET29298. 416p. NTIS, PC A18/MF A01.

A method for distribution transformer loss evaluation was derived. The total levalized annual cost method was used and was extended to account properly for conditions of energy cost inflation, peak load growth, and transformer changeout during the evaluation period. The loss costs included were the no-load and load power losses, no-load and load reactive losses, and the energy cost of regulation. The demand and energy components of loss costs were treated separately to account correctly for the diversity of load losses and energy cost inflation. The complete distribution transformer loss evaluation equation is shown, with the nomenclature and definitions for the parameters provided. Tasks described are entitled: Establish Loss Evaluation Techniques; Compile System Cost Parameters; Compile Load Parameters and Loading Policies; Develop Transformer Cost/Performance Relationship; Define Characteristics of Multiple Efficiency Transformer Package; Minimize Life Cycle Cost Based on Single Efficiency Characteristic Transformer Design; Minimize Life Cycle Cost Based on Multiple Efficiency Characteristic Transformer Design; and Interpretation.

AC SYSTEMS, EHV AND UHV

27207 (CONF-800421—4) **Robustness of controllability and observability of linear time-varying systems with application to the emergency control of power systems.** Sastry, S.S.; Desoer, C.A.

(California Univ., Berkeley (USA). Dept. of Electrical Engineering and Computer Sciences). 1980. Contract AC01-79ET29364. 51p. NTIS, PC A04/MF A01.

From IEEE international symposium on circuits and systems; Houston, TX, USA (28 Apr 1980).

Fixed point methods from nonlinear anaysis are used to establish conditions under which the uniform complete controllability of linear time-varying systems is preserved under non-linear perturbations in the state dynamics and the zero-input uniform complete observability of linear time-varying systems is preserved under non-linear perturbation in the state dynamics and output read out map. Algorithms for computing the specific input to steer the perturbed systems from a given initial state to a given final state are also presented. As an application, a very specific emergency control of an interconnected power system is formulated as a steering problem and it is shown that this emergency control is indeed possible in finite time.

27208 (CONS—2056-T1) **Design, manufacture, test and delivery of a 230 kV extruded irradiated crosslinked polyethylene cable. Final report .** (Reynolds Metals Co., Richmond, VA (USA)). 1978. Contract EX-76-C-01-2056. 428p. NTIS, PC A19/MF A01.

A project was initiated to develop a 230 kV solid dielectric cable for use in underground transmission. The dielectric is to be polyethylene, crosslinked by electron bombardment. Compared to the more conventional chemically crosslinked polyethylene, the irradiated cable is expected to contain less sensitive defects and thus be more suitable for a 230 kV rating. A toroidally shaped diode was developed to provide a uniform radiation dose to a thick-walled coaxial cable. The diode is to receive an output wave form obtained by ringing a Marx generator into a peaking capacitor. Initial evaluation of the toroidal diode was performed on thin plaques and tapes of insulating and semi-conducting polyethylene polymers. Additionally, some miscellaneous ethylene plastics were briefly investigated. Using a 4.8 MV Van de Graaff pulse generator in conjunction with several diode configurations, 15 to 35 kV extruded HMW-PE cables were irradiated. Dose rate, temperature, and pressure effects were evaluated. It was found that with limited dose rate it was possible to produce excellent crosslink density and uniformity at room temperature and atmospheric pressure. A subsequent 60 Hz voltage endurance test on an irradiated cable sample indicated it had long term, high stress capability. An engineering study conducted to determine an acceptable irradiator system design is reported. It was estimated that a 7 MV peak voltage at a rate of 2 to 3 pulse/sec can be provided by a Marx generator/peaking capacitor and should be capable of crosslinking a polyethylene wall thickness of approximately 2.5 cm. Based on the accumulated test results and on the performance of the 7 MV irradiator predicted, it appears feasible to continue the work effort into the next scheduled phase.

27209 (CONS—3029-T4) **Elimination of particle effects in SF_6 insulated transmission systems. Fifth quarterly report, October 1, 1978-June 26, 1980.** Dale, S.J. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). 1980. Contract ET-78-C-01-3029. 48p. NTIS, PC A03/MF A01.

Progress is reported in a program for developing methods and equipment to eliminate the adverse effect of particle contamination in SF_6-insulated transmission systems, CGIT. Presently, CGIT systems are operated at about 10% of the dielectric strength capability of the SF_6 gas. Tests were made to compare a slotted particle trap elevated above the enclosure with a particle trap with slots flush with the enclosure surface. Aging tests on adhesive materials for particle traps are continuing. Mechanical vibration cleaning of the enclosure has been completed. A combination of air flow and mechanical vibration was found to be the most successful method and comparable to present methods of sheath cleaning. The results show that the application of the hybrid electrostatic-adhesive traps in combination with an effective voltage conditioning procedure offers the prospects of improved reliability for CGIT systems. (LCL)

27210 (DOE/RA/2134—01) **Evaluation of advanced technologies for power transformers. Final report. Part I, November 1976-March 1979.** (General Electric Co., Schenectady, NY (USA)). Jun 1980. Contract AC01-77ET29069. 185p. NTIS, PC A09/MF A01.

The high insulating strength of certain gases, such as sulfur hexafluoride, when used at high pressure, suggests that there may be advantages to compressed gases as the insulating fluid in power transformers. However, simply exchanging the oil for compressed gas in an otherwise conventional transformer design will not yield a significant overall advantage. Compressed gases present the engineer with properties which are quite different from mineral oil. If gases are to be used as the major insulating fluid in power transformers, then virtually all aspects of the insulation and cooling of the apparatus must be reconsidered, affording an opportunity to introduce new design concepts, new materials, and new construction techniques. In this program, the feasibility of using the following principal design concepts has been explored: sheet conductors for the windings; a system of sealed, self-contained, annular cooling ducts containing circulating cooling fluid to cool the windings; polymer film for turn-to-turn insulation; and compressed gas insulation. Experimental and analytical studies, described in this report, indicate that the sheet-wound, compressed-gas-insulated design should result in power transformers of significantly smaller size and weight when compared with oil-filled units of equivalent rating. These advanced technologies offer the opportunity for the design of more efficient power transformers.

27211 (EPRI-EL—1314(Vol.1)) **Bundled circuit design for 115-138 kV compact transmission lines. Final report.** Grant, I.S.; Wilson, D.D.; Longo, V.J.; Stewart, J.R. (Power Technologies, Inc., Schenectady, NY (USA)). Feb 1980. 271p. NTIS, PC A12/MF A01.

Design information for 115 to 138 kV bundled circuit transmission line designs is documented. Bundled circuit lines combine compact line principles with the bundled conductor technology commonly used on EHV transmission lines. By supporting the three phase conductors with a complete insulator system rather than individual phase insulators, and by adding insulating midspan spacers where necessary to maintain clearances between conductors, a circuit can be designed requiring little more space than a conventional 3-conductor bundle. Such designs offer advantages for compact application, particularly for appearance and ease in uprating existing lines. Non-ceramic fiberglass-cored insulators which are strong, resilient, lightweight, and visually unobtrusive are an important complement to this construction. This volume details specific methods, information, recommendations and examples for bundled circuit design.

27212 (EPRI-EL—1314(Vol.2)) **Bundled circuit design for 115-138 kV compact transmission lines. Final report.** Grant, I.S.; Wilson, D.D.; Longo, V.J.; Stewart, J.R. (Power Technologies, Inc., Schenectady, NY (USA)). Feb 1980. 396p. NTIS, PC A17/MF A01.

Design information for 115 to 138 kV bundled circuit transmission line designs is documented. Bundled circuit lines combine compact line principles with the bundled conductor technology commonly used on EHV transmission lines. By supporting the three phase conductors with a complete insulator system rather than individual phase insulators, and by adding insulating midspan spacers where necessary to maintain clearances between conductors, a circuit can be designed requiring little more space than a conventional 3-conductor bundle. Such designs offer advantages for compact application, particularly for appearance and ease in uprating existing lines. Non-ceramic fiberglass-cored insulators which are strong, resilient, lightweight, and visually unobtrusive are an important complement to this construction. This volume presents results and details of the research on which the design procedures are based. Research work described includes energized testing of bundle circuit lines with 2- and 3-ft phase spacings, development, construction and testing of insulator systems and insulating midspan spacers, measurement of conductor motions from shock loads such as ice shedding and fault currents, and an evaluation of the use of covered conductor at 138 kV. In addition, results of analytical work include development of a model for conductor motion and forces in midspan spacers; advanced design evaluations; electrical performance characteristics; and cost studies for new and uprated construction.

27213 (SWRI—14-5277) **Preliminary study of the behavioral and biological effects of high intensity 60 HZ electric fields. Interim technical progress report No. 4.** Feldstone, C.; Spiegel, R.J.; Winters, W.; Polonis, J.J. (Southwest Research Inst., San Antonio, TX (USA)). 1 Mar 1980. Contract ET-78-C-01-2875. 119p. NTIS, PC A06/MF A01.

Progress is reported in studies of the effects of high intensity 60 Hz electric fields on baboon behavior - both individual performance (operant conditioning) and natural (social) behavior. The result of the study should be either a clear indication of the electric field intensity which produces deleterious effects in the baboon or an indication that the highest field intensity of practical interest (analogous to the highest intensity that can be encountered by man under power lines) produces no deleterious effects. The generalization of results to man will be futher aided by the development of models relating the physical effects of electric fields on man to the physical effects on the baboon. (LCL)

DC SYSTEMS

27214 (EPRI-EL—1259) **Porous polymer tape screening program. Final report.** Bur, A.J. (National Bureau of Standards, Washington, DC (USA). Polymer Science and Standards Div.). Dec 1979. 80p. NTIS, PC A05/MF A01.

A screening program has been developed for porous polymer tapes which are considered to be candidates for a tape-oil insulation system in a high-voltage transmission cable. The program consists of 21 tests for measuring mechanical, electrical and physical properties. Descriptions of most of these tests have been published in ASTM test schedules or in other literature sources. Two of the tests had to be developed in our laboratories. They are the degree-of-void-filling test and the solubility test. For the degree-of-void-filling test, a

buoyancy measurement is utilized to calculate the void volume which is not filled by the permeating oil. Two buoyancy measurements are made: first, the specimen is immersed in a calibration fluid which is assumed to permeate all voids in the specimen. A true specimen density is calculated and then compared to an apparent density which is obtained from the specimen immersed in oil. The difference in the two densities is proportional to the reciprocal of the unfilled void volume. Four materials and two oils have been used for these experiments. The materials are a polypropylene synthetic paper (PPSP), a porous polypropylene (PP), a polyethylene synthetic paper (PE) and a paper-polypropylene-paper laminate (PPP). The oils are an alkyl benzene oil and a polybutene oil. The results show a range of void filling from very little for PPSP to complete filling for PP.

27215 (EPRI-EL—1395) **Fault data acquisition system and data logger for HVDC compact terminals. Final report.** Goldy, D.J.; Hofferber, D.D.; Veraya, M.J. (Boeing Engineering and Construction Co., Seattle, WA (USA)). Apr 1980. 191p. NTIS, PC A09/MF A01.

Unreliable and uncoordinated data are commonly the only information available to the engineer who analyzes power system disturbances. The volume of data required is generally very large, and the types of data needed are not readily collectable by station operators. A new data acquisition system that will provide operational, sequence-of-event and oscillographic fault data is now available. These data are related to a common time base and are made available to a remotely located operator within minutes after a disturbance. A prototype system designed for high-voltage direct-current (HVDC) system applications has been built, tested, and installed at EPRI's prototype dc link in New York City. The developed system is also applicable to alternating current substations.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

27216 (BNL—27331) **Bending behavior of lapped plastic ehv cables.** Morgan, G.H.; Muller, A.C. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 6p. (CONF-800605—2). NTIS, PC A02/MF A01.

From International symposium on electrical insulation; Boston, MA, USA (9 Jun 1980).

One of the factors delaying the development of lapped polymeric cables has been their reputed poor bending characteristics. Complementary programs were begun at BNL several years ago to mathematically model the bending of synthetic tape cables and to develop novel plastic tapes designed to have moduli more favorable to bending. A series of bend tests was recently completed to evaluate the bending performance of several tapes developed for use in experimental superconducting cables. The program is discussed and the results of the bend tests are summarized.

27217 (BNL—51150) **Semiannual report for the period April 1-September 30, 1979 of work on: (1) Superconducting power transmission development; (2) Cable insulation development. Power Transmission Project Technical Note No. 99.** (Brookhaven National Lab., Upton, NY (USA)). 15 Jan 1980. Contract AC02-76CH00016. 83p. NTIS, PC A05/MF A01.

The objective of the program is to develop an underground superconducting power transmission system which is economical and technically attractive to the utility industry. The system would be capable of carrying very large blocks of electric power, thus enabling it to supplant overhead lines in urban and suburban areas and regions of natural beauty. The program consisted initially of work in the laboratory to develop suitable materials, cryostats, and cable concepts. The materials work covers the development and testing of suitable superconductors and dielectric insulation. The laboratory work has now been extended to an outside test facility which represents an intermediate step between the laboratory scale and a full-scale system. The facility will allow cables several hundred feet long to be tested under realistic conditions. In addition, the refrigerator has been designed for optimum service for utility applications.

27218 (CONS—3015-T5) **Superconducting fault current limiter. Fifth quarterly technical progress report, August 8, 1978-November 7, 1979.** (Gould-Brown Boveri, Spring House, PA (USA)). 1979. Contract ET-78-C-01-3015. 124p. NTIS, PC A06/MF A01.

Progress in the development of fault current limiters for superconducting power transmission systems is reported. The analysis and design of a magnetically switched resistive device and the experimental program were emphasized and reported. A transient heat transfer model was developed which indicates the parameters which are important in determining the thermal heating and recovery of the superconduting film. Designs for the switching coil and the S/C element were also carried out and are reported. A four-pole magnetic coil is recommended; this generates a magnetic field which is nearly perpendicular to spiral or helical S/C film geometrics. A spirally-designed, 3000 ohm limiter is shown to be able to fit within a .5 to 1m inner radius, .05 to .03 m wide, 1.3 to 3.9 m long annualr region. The experimental program has included work on materials development and on prepartion of the switching and thermal recovery experimental facility. The material development program has uncovered several serious short-comings of NbN as the S/C film material. Macroscopic holes and surface debris, and microscopic imperfections reduce the critical current density below the expected value and, in addition, cause nonuniform switching. Reasons for these effects are postulated, and a continuing, vigorous materials program is suggested in hopes of alleviating these problems. Virtually all of the experimental equipment had been installed, and so the magnetic switching and thermal recovery experiments can begin and progress during the next quarter. (LCL)

NUCLEAR POWER PLANTS

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 27232, 27234, 27240, 27241, 27244

27219 (COO—2985-25) **Dilute chemical decontamination program. Quarterly report 4, July 1-September 30, 1978.** Anstine, L.D. (General Electric Co., Pleasanton, CA (USA). Vallecitos Nuclear Center). Jan 1979. Contract AC02-76ET34203. 54p. (NEDC—12705-4). NTIS, PC A04/MF A01.

Information is presented concerning reagent evaluation and selection; and corrosion test program.

27220 (DOE/ET/34215—14) **Fuel performance improvement program: description and characterization of HBWR Series H-2, H-3, and H-4 test rods.** Guenther, R.J.; Barner, J.O.; Welty, R.K. (Battelle Pacific Northwest Labs., Richland, WA (USA); Exxon Nuclear Co., Inc., Richland, WA (USA)). Mar 1980. Contract AC06-76RL01830; AC02-76ET34215. 143p. NTIS, PC A08/MF A01.

The fabrication process and as-built characteristics of the HBWR Series H-2 and H-3 test rods, as well as the three packed-particle (sphere-pac) rods in HBWR Series H-4 are described. The HBWR Series H-2, H-3, and H-4 tests are part of the irradiation test program of the Fuel Performance Improvement Program. Fifteen rods were fabricated for the three test series. Rod designs include: (1) a reference dished pellet design incorporating chamfered edges, (2) a chamfered, annular pellet design combined with graphite-coated cladding, and (3) a sphere-pac design. Both the annular-coated and sphere-pac designs include internal pressurization using helium.

27221 (MLM—2704) **Economics of isotopic tailoring for light-water reactor structural materials.** Michaels, E.D. (Mound Facility, Miamisburg, OH (USA)). 18 Jun 1980. Contract AC04-76DP00053. 9p. NTIS, PC A02/MF A01.

In order to assess the economic potential of the application of elementally pure isotopically tailored (E.P.I.T.) materials to the problem of reducing induced radioactivity in light-water power reactors, a hypothetical case has been postulated. Conceptual designs of an iron purification plant and a nickel isotope separation plant (based upon chemical exchange technology) have been prepared and the capital and operating costs of these plants have been estimated. The rate of return on the incremental investment of the E.P.I.T. materials was calculated to be approximately 14% (in a constant-dollar economy), which appears to justify additional work on this potential application of E.P.I.T. materials.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 27221, 27232, 27234, 27237, 27240, 27241, 27243, 27244

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 27263

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 26948, 27236, 27238

27222 (CONF-800648—1) **GCFR thermal-hydraulic experiments.** Schlueter, G.; Baxi, C.B.; Dalle Donne, M.; Gat, U.; Fenech, H.; Hanson, D.; Hudina, M. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 28p. NTIS, PC A03/MF A01.

From GCFRP program technical review meeting; San Diego, CA, USA (4 Jun 1980).

The thermal-hydraulic experimental studies performed and planned for the Gas-Cooled Fast Reactor (GCFR) core assemblies are described. The experiments consist of basic studies performed to obtain correlations, and bundle experiments which provide input for code validation and design verification. These studies have been performed and are planned at European laboratories, US national laboratories, Universities in the US, and at General Atomic Company

27223 (JAPFNR—514) **Fast Breeder Reactor development in Japan. Progress report, January-March 1979. PNC-N—251-79-06.** (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). 1979. 21p. NTIS (US Sales Only), PC A02/MF A01.

Work performed under United States-Japanese Fast Reactor Exchange Program.

Information is presented concerning the development program for the JOYO reactor; development program for the MONJU reactor; fast reactor physics; instrumentation and control; sodium technology; fuel materials; reactor structural materials; safety; and steam generators.

27224 (PNL-TR—396) **Operating experience of the BN-350 fast reactor (1972-1977).** Yurchenko, D.S.; Vasilenko, K.T.; Demin, A.A.; Pomerantsev, G.B.; Samarkin, A.A.; Skorikov, N.V.; Tverdovskii, I.D.; Shkol'nik, V.S. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 14 Apr 1980. Contract EY-76-C-06-1830. 36p. (CONF-780407—12). NTIS, PC A03/MF A01.

From Symposium on design, construction and operating experience of demonstration liquid metal fast breeder reactors; Bologna, Italy (10 Apr 1978).

The start-up and power commissioning of the BN-350 reactor are reported together with the results of experimental studies. The main results of operation from the time the reactor reached a power level of 650 MW(t) until 1 January 1978 are given. Operating experience with the principal equipment and technological systems is discussed and radiation conditions are described. The cases of failure of the steam generator heat-transfer surfaces are considered.

27225 (DOE-tr—150) **Analysis of neutron noise in sodium cooled reactors for the recognition of malfunctions.** Hoppe, P. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.)). Sep 1979. Translation of KFK—2589. 146p. NTIS (US Sales Only), PC A07/MF A01.

Thesis. Work performed under United States-W. Germany Fast Reactor Exchange Program.

The goal of this work is to determine by measurements on the KNK I and their evaluation, just how far the noise signals from neutron detectors can be used for the recognition of functional interferences in sodium cooled reactors. The foundation step of this task is that the sources of neutron noise in various reactor statuses of the KNK I are identified as far as possible. In this it is important to consider the available experience derived from measurements made on other power reactors, with respect to noise sources and methods of identifying them. In a second step, it will be necessary to study just how far it is possible to transfer the results of those studies to the consideration of a typical sodium cooled reactor like the SNR 300.

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 27033

ECONOMICS

CONSTRUCTION AND OPERATION

REFER ALSO TO CITATION(S) 27231

27226 (DOE/NE—0009) **Power plant capital investment cost estimates: current trends and sensitivity to economic parameters.** (Oak Ridge National Lab., TN (USA); United Engineers and Constructors, Inc., Philadelphia, PA (USA)). Jun 1980. Contract W-7405-ENG-26. 63p. NTIS, PC A04/MF A01.

This report describes power plant capital investment cost studies that were carried out as part of the activities of the Plans and Analysis Division, Office of Nuclear Energy Programs, US Department of Energy. The activities include investment cost studies prepared by an architect-engineer, including trends, effects of environmental and safety requirements, and construction schedules. A computer code used to prepare capital investment cost estimates under varying economic conditions is described, and application of this code is demonstrated by sensitivity studies.

FUEL CYCLE

27227 (DOE/NE—001/6F) **Nuclear proliferation and civilian nuclear power. Report of the Nonproliferation Alternative Systems Assessment Program. Volume VI. Safety and environmental considerations for licensing.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Nuclear Energy). Jun 1980. 152p. NTIS, PC A08/MF A01.

This volume of the Nonproliferation Alternative Systems Assessment Program report addresses safety and environmental considerations in licensing the principal alternative nuclear reactors and fuel cycles in the United States for large-scale commercial nuclear power plants. In addition, this volume examines the safety and environmental considerations for licensing fuel service centers. These centers, which have been proposed for controlling sensitive fuel-cycle facilities and special nuclear materials, would contain a combination of such facilities as reprocessing plants, fabrication plants, and reactors. For this analysis, two fuel service center concepts were selected - one with power - generating capability and one without.

27228 (DOE/NE—0001/1F) **Nuclear proliferation and civilian nuclear power. Report of the Nonproliferation Alternative Systems Assessment Program. Volume I. Program summary.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Nuclear Energy). Jun 1980. 81p. NTIS, PC A05/MF A01.

This report summarizes the Nonproliferation Alternative Systems Assessment Program (NASAP): its background, its studies, and its results. The introductory chapter traces the growth of the issue of nuclear weapons proliferation and the organization and objectives of NASAP. Chapter 2 summarizes the program's assessments, findings, and recommendations. Each of Volumes II-VII reports on an individual assessment (Volumn II: Proliferation Resistance; Volume III: Resources and Fuel Cycle Facilities; Volume IV: Commercial Potential: Volume V: Economics and Systems Analysis; Volume VI: Safety and Environmental Considerations for Licensing; Volume VII: International Perspectives). Volume VIII (Advanced Concepts) presents a combined assessment of several less fully developed concepts, and Volume IX (Reactor and Fuel Cycle Descriptions) provides detailed descriptions of the reactor and fuel-cycle systems studied by NASAP.

27229 (DOE/NE—0001/2F) **Nuclear proliferation and civilian nuclear power. Report of the Nonproliferation Alternative Systems Assessment Program. Volume II. Proliferation resistance.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Nuclear Energy). Jun 1980. 200p. NTIS, PC A09/MF A01.

The purpose of this volume is limited to an assessment of the relative effects that particular choices of nuclear-power systems, for whatever reasons, may have on the possible spread of nuclear-weapons capabilities. This volume addresses the concern that non-nuclear-weapons states may be able to initiate efforts to acquire or to improve nuclear-weapons capabilities through civilian nuclear-power programs; it also addresses the concern that subnational groups may obtain and abuse the nuclear materials or facilities of such programs, whether in nuclear-weapons states (NWS's) or non-nuclear-weapons states (NNW's). Accordingly, this volume emphasizes one important factor in such decisions, the resistance of nuclear-power systems to the proliferation of nuclear-weapons capabilities.

27230 (DOE/NE—0001/3F) **Nuclear proliferation and civilian nuclear power. Report of the Nonproliferation Alternative Systems Assessment Program. Volume III. Resources and fuel cycle facilities.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Nuclear Energy). Jun 1980. 197p. NTIS, PC A09/MF A01.

The ability of uranium supply and the rest of the nuclear fuel cycle to meet the demand for nuclear power is an important consideration in future domestic and international planning. Accordingly, the purpose of this assessment is to evaluate the adequacy of potential supply for various nuclear resources and fuel cycle facilities in the United States and in the world outside centrally planned economy areas (WOCA). Although major emphasis was placed on uranium supply and demand, material resources (thorium and heavy water) and facility resources (separative work, spent fuel storage, and reprocessing) were also considered.

27231 (DOE/NE—0001/4F) **Nuclear proliferation and civilian nuclear power. Report of the Nonproliferation Alternative Systems Assessment Program. Volume IV. Commercial potential.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Nuclear Energy). Jun 1980. 305p. NTIS, PC A14/MF A01.

This volume of the Nonproliferation Alternative Systems Assessment Program (NASAP) report provides time and cost estimates for positioning new nuclear power systems for commercial deployment. The assessment also estimates the rates at which the

new systems might penetrate the domestic market, assuming the continuing viability of the massive light-water reactor network that now exists worldwide. This assessment does not recommend specific, detailed program plans and budgets for individual systems; however, it is clear from this analysis that any of the systems investigated could be deployed if dictated by national interest.

27232 (DOE/NE—0001/5F) **Nuclear proliferation and civilian nuclear power. Report of the Nonproliferation Alternative Systems Assessment Program. Volume V. Economics and systems analysis.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Nuclear Energy). Jun 1980. 99p. NTIS, PC A05/MF A01.

This NASAP assessment considers the economics of alternative nuclear reactor and fuel-cycle systems in the light of possible patterns of uranium supply and energy demand, as well as the economic implications of improvng the proliferation resistance of the various systems. The assessment focuses on the costs of alternative nuclear technologies and the possible timing of their implementation, based on their economic attractiveness.

27233 (DOE/NE—0001/8F) **Nuclear proliferation and civilian nuclear power. Report of the Nonproliferation Alternative Systems Assessment Program. Volume VIII. Advanced concepts.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Nuclear Energy). Jun 1980. 110p. NTIS, PC A06/MF A01.

The goal of the Nonproliferation Alternative Systems Assessment Program has been to provide recommendations for the development and deployment of more proliferation-resistant civilian nuclear-power systems without jeopardizing the development of nuclear energy. In principle, new concepts for nuclear-power systems could be designed so that materials and facilities would be inherently more proliferation-resistant. Such advanced, i.e., less-developed systems, are the subject of this volume. Accordingly, from a number of advanced concepts that were proposed for evaluation, six representative concepts were selected: the fast mixed-spectrum reactor; the denatured molten-salt reactor; the mixed-flow gaseous-core reactor; the linear-accelerator fuel-regenerator reactor; the ternary metal-fueled electronuclear fuel-producer reactor; and the tokamak fusion-fission hybrid reactor.

27234 (DOE/NE—0001/9F) **Nuclear proliferation and civilian nuclear power. Report of the Nonproliferation Alternative Systems Assessment Program. Volume IX. Reactor and fuel cycle description.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Nuclear Energy). Jun 1980. 625p. NTIS, PC A99/MF A01.

The Nonproliferation Alterntive Systems Assessment Program (NASAP) has characterized and assessed various reactor/fuel-cycle systems. Volume IX provides, in summary form, the technical descriptions of the reactor/fuel-cycle systems studied. This includes the status of the system technology, as well as a discussion of the safety, environmental, and licensing needs from a technical perspective. This information was then used in developing the research, development, and demonstration (RD and D) program, including its cost and time frame, to advance the existing technology to the level needed for commercial use. Wherever possible, the cost data are given as ranges to reflect the uncertainties in the estimates.

NUCLEAR REACTOR TECHNOLOGY

FUEL ELEMENTS

27235 Survey of the chemical environments for activity in the embrittlement of Zircaloy-2. Grubb, W.T.; Morgan, M.H. III. (GE, Schenectady, NY). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 681, 145-154(1978). (CONF-780637—).

From 4. symposium on zirconium in the nuclear industry; Stratford-on-Avon, UK (27 Jun 1978).

Thirty-five chemical elements and some of their compounds were tested for activity in the embrittlement of Zircaloy-2 at 573$degree$K using constant extension rate tension tests. Besides iodine, which embrittles by stress corrosion cracking (SCC), five metals caused liquid metal embrittlement when dissolved in cesium. These were cadmium, zinc, yttrium, calcium, and strontium. The effect of cadmium was by far the most severe. Selenium and tellurium did not embrittle Zircaloy-2 by SCC. Of the embrittling metals, only cadmium is considered a likely contributor to the PCI (pellet-clad interaction) failure mechanism. The reasons for this conclusion are discussed. 19 refs.

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 27237

CHEMICAL AND THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 27911

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 27223

REACTOR SAFETY

27236 (ANL—80-6) **SACO-1: a fast-running LMFBR accident-analysis code.** Mueller, C.J.; Cahalan, J.E.; Vaurio, J.K. (Argonne National Lab., IL (USA)). Jan 1980. Contract W-31-109-ENG-38. 328p. NTIS, PC A15/MF A01.

SACO is a fast-running computer code that simulates hypothetical accidents in liquid-metal fast breeder reactors to the point of permanent subcriticality or to the initiation of a prompt-critical excursion. In the tradition of the SAS codes, each subassembly is modeled by a representative fuel pin with three distinct axial regions to simulate the blanket and core regions. However, analytic and integral models are used wherever possible to cut down the computing time and storage requirements. The physical models and basic equations are described in detail. Comparisons of SACO results to analogous SAS3D results comprise the qualifications of SACO and are illustrated and discussed.

27237 (CONF-800607—60) **Emergency actions concerned with effluent control at TMI.** Brooksbank, R.E.; Campbell, D.O.; Snider, J.W.; Yarbro, O.O. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 34p. NTIS, PC A03/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

Information is presented concerning the critical emergency requirements; gaseous effluent status and control; liquid effluent status and control; and water treatment processes.

27238 (JAPFNR—511) **UZU-three dimensional analytical code for local flow blockage in a nuclear fuel subassembly. PNC-N—941-79-08.** Miyaguchi, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Jan 1979. 12p. NTIS (US Sales Only), PC A02/MF A01.

Work performed under United States-Japanese Fast Reactor Exchange Program.

In several countries many experimental and analytical studies have been performed to investigate local blockage problems in LMFBR subassemblies, and even 3 dimensional computer codes have been developed. The numerical results of these codes are qualitatively correct, but it seems that they are not yet quantitatively verified by experiments. In the Oarai Engineering Center, PNC, Japan a series of hydraulic simulation experiments and the experiments in sodium-cooled, electrically heated bundles have been conducted, and in parallel with experimental studies analytical codes have been developed. The purpose of the present paper is to describe one of these codes, UZU, which calculates flow and temperature fields in the wake behind a blockage in a pin bundle.

27239 Can we fix nuclear energy. Weinberg, A.M. (Oak Ridge Associated Universities, Inc., TN ;USA). Inst. for Energy Analysis). *Ann. Nucl. Energy;* **6**: No. 9-10, 473-482(1979).

The status of nuclear energy is examined from the safety aspect. Attitudes to siting and the performance of existing safety barriers for protection against radioactivity released from power stations are discussed. Amongst the problems associated with the operation of a nuclear reactor, mine tailings are considered a greater hazard than either waste disposal or proliferation. The effect of the Three Mile island accident on the estimation of the probability of serious malfunctioning of a reactor is examined. An acceptable nuclear energy system is identified in terms of the following characteristics:-greater isolation of sites, development of a safer reactor type, the separation of nuclear electricity generation from its distribution; more professionlization of staff for nuclear plants, greater security, and education of the public about the hazards of radiation. A brief examination of alternative energy sources suggests that solar energy is worth pursuing. This, however, will be a long-term project and exponents of nuclear energy must provide new and convincing initiatives in order to gain public approval for nuclear power.

27240 Comparison of experimental cladding microstructure resulting from uranium oxide-Zircaloy interaction with a diffusional assessment of oxygen transport for a coupled two-media problem. Cronenberg, A.W.; El-Genk, M.S. (Ederton, Germeshausen and Grier, Inc, Idaho, Idaho Falls). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 681, 354-369(1978). (CONF-780637—).

From 4. symposium on zirconium in the nuclear industry; Stratford-on-Avon, UK (27 Jun 1978).

During high-temperature transients on Zircaloy-clad nuclear fuel rods, both external and internal cladding oxidation have been observed. The result of such oxidation is to embrittle the cladding, making it susceptible to brittle fracture. External oxidation of Zirca-

loy in a steam environment is relatively well understood, while the internal processes have received little attention. This paper examines the internal oxidation process that occurs as a result of oxygen transport from the uranium oxide fuel pellets to the Zircaloy cladding. An oxygen diffusion model has been derived that solves a coupled two-medium problem with a moving boundary in Zircaloy due to the α-β phase change. Analytical results for the time and temperature dependence of such Zircaloy oxidation were found to compare favorably with both in- and out-of-pile experimental data, indicating that the underlying oxidation process is diffusion controlled. 12 refs.

27241 Zirconium in the Nuclear Industry: Proceedings of the International Conference, 4th, 1978. Papazoglou, T.P. (Ed.). (Babcock and Wilcox Co, Lynchburg, Va). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 681, 627(1978). (CONF-780637—).

From 4. symposium on zirconium in the nuclear industry; Stratford-on-Avon, UK (27 Jun 1978).

This conference contains 35 papers all of which are indexed separately. In general the conference covers zirconium alloys used in light water reactor fuel cladding applications. The broad topics covered include effects of reactor environments, pellet-cladding interaction, and cladding deformation and oxidation during transients.

27242 Zirconium cladding deformation in a steam environment with transient heating. Chapman, R.H.; Crowley, J.L.; Longest, A.W.; Hofmann, G. (Oak Ridge Natl Lab, Tenn). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 681, 393-408(1978). (CONF-780637—).

From 4. symposium on zirconium in the nuclear industry; Stratford-on-Avon, UK (27 Jun 1978).

Zircaloy-4 cladding is being tested under loss-of-coolant accident (LOCA) conditions to determine its deformation behavior and to provide data for verification of analytical models. Data obtained thus far from 34 single-rod tests imply less ballooning, and consequently less flow restriction, than would be predicted from earlier data. The instrumented simulators, consisting of unirradiated Zircaloy-4 cladding with an internal heater to simulate fuel pellet heating, are tested to failure in superheated steam over a wide range of internal pressures at a temperature increase rate of about 28$degree$C/s. Cladding surface temperature and internal pressure data are recorded during the transient and deformation measurements are obtained posttest. An analytical expression is given for the burst temperature as a function of burst pressure. The experimental results show excellent correlation between cladding deformation and surface temperature distribution. Deformation is extremely sensitive to small temperature variations. 13 refs.

27243 Embrittlement of Zircaloy-clad fuel rods irradiated under film boiling conditions. Hobbins, R.R.; Seiffert, S.L.; Ploger, S.A.; Mehner, A.S.; MacDonald, P.E. (Edgerton, Germeshausen and Grier, Inc, Idaho Falls, Idaho). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 681, 586-599(1978). (CONF-780637—).

From 4. symposium on zirconium in the nuclear industry; Stratford-on-Avon, UK (27 Jun 1978).

Pressurized water reactor type fuel rods are being irradiated under postulated accident conditions in the Power Burst Facility at the Idaho National Engineering Laboratory as part of the Thermal Fuels Behavior Program. In these tests, film boiling was achieved by establishing a mismatch reactor power and coolant flow, while maintaining the coolant pressure at 15 MPa. Cladding embrittlement resulting from film boiling operation of intact fuel rods was found to be consistent with previously established embrittlement criteria based on oxygen content in $beta$-Zircaloy, but not with previously established criteria based on either fractional thickness of transformed $beta$ or equivalent cladding reacted. Rods that were operated with breached cladding were embrittled to a greater degree than intact fuel rods under similar oxidizing conditions. 14 refs.

27244 Development of an oxygen embrittlement criterion for Zircaloy cladding applicable to loss-of-coolant accident conditions in light-water reactors. Chung, H.M.; Garde, A.M.; Kassner, T.F. (Argonne Natl Lab, Ill). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 681, 600-627(1978). (CONF-780637—).

From 4. symposium on zirconium in the nuclear industry; Stratford-on-Avon, UK (27 Jun 1978).

To establish the mechanical response of Zircaloy cladding under thermal shock conditions typical of hypothetical loss-of-coolant accident (LOCA) situations in light-water reactors (LWRs), cladding specimens were ruptured in steam during transient heating (10 K/s), oxidized at maximum temperatures between 1140 and 1770 K for various times, and cooled from the isothermal oxidation temperature to $similar$1100 K at a rate of 5 K/s, and rapidly quenched by bottom flooding with water at a rate of $similar$0.05 m/s. Failure "maps" for fracture of the cladding by thermal shock were developed relative to the maximum oxidation temperature and various time-dependent oxidation parameters. In situ pendulum-load impact tests were conducted at room temperature on tubes that survived the thermal quench. Information on the total absorbed energy from these tests was correlated with more extensive results from instrumented drop-weight impact tests. 23 refs.

ENERGY STORAGE

27245 (LA—8308-MS) Assessment of environmental control technologies for energy storage systems - 1979. Krupka, M.C.; Moore, J.E.; Keller, W.E.; Baca, G.A.; Brasier, R.I.; Bennett, W.S. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 123p. NTIS, PC A06/MF A01.

The US Department of Energy has emphasized the development of several advanced energy storage technologies. These have major applications in the areas of transportation, building heating and cooling, industrial processes and electric power generation. It is expected that the storage technologies will have certain environmental impacts for which control technology will be required. An update is presented to a previous study within which environmental impacts were identified, control techniques were described and recommendations for needed control technology were made. The storage technologies investigated at that time included: lead-acid battery, hydroelectric pumped, superconducting magnet, compressed air, flywheel and thermal. Additional work relative to these technologies are updated and a new section on the environmental impacts of fuel cell technology is presented. Although not strictly energy storage devices, many of the benefits attributed to fuel cells are similar to those of the other storage systems. In addition, sections on new applications for energy storage technologies and the additional costs of controls to be used for mitigation of certain adverse impacts are also presented. Detailed discussion of the various environmental impacts as they relate to primarily operational situations are emphasized. A brief discussion is presented relating to the possible implications of the Resource Conservation and Recovery Act (RCRA) upon the disposal of any solid waste materials that have been generated.

COMPRESSED GAS

27246 (PNL—3294) Porous media experience applicable to field evaluation for compressed air energy storage. Allen, R.D.; Gutknecht, P.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76RL01830. 98p. NTIS, PC A05/MF A01.

A survey is presented of porous media field experience that may aid in the development of a compressed air energy storage field demonstration. Work done at PNL and experience of other groups and related industries is reviewed. An overall view of porous media experience in the underground storage of fluids is presented. CAES experience consists of site evaluation and selection processes used by groups in California, Kansas, and Indiana. Reservoir design and field evaluation of example sites are reported. The studies raised questions about compatibility with depleted oil and gas reservoirs, storage space rights, and compressed air regulations. Related experience embraces technologies of natural gas, thermal energy, and geothermal and hydrogen storage. Natural gas storage technology lends the most toward compressed air storage development, keeping in mind the respective differences between stored fluids, physical conditions, and cycling frequencies. Both fluids are injected under pressure into an aquifer to form a storage bubble confined between a suitable caprock structure and partially displaced ground water. State-of-the-art information is summarized as the necessary foundation material for field planning. Preliminary design criteria are given as recommendations for basic reservoir characteristics. These include geometric dimensions and storage matrix properties such as permeability. Suggested ranges are given for injection air temperature and reservoir pressure. The second step in developmental research is numerical modeling. Results have aided preliminary design by analyzing injection effects upon reservoir pressure, temperature and humidity profiles. Results are reported from laboratory experiments on candidate sandstones and caprocks. Conclusions are drawn, but further verification must be done in the field.

27247 (PNL—3395) Compressed air energy storage technology program. Annual report for 1979. Loscutoff, W.V. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76RL01830. 197p. NTIS, PC A09/MF A01.

The objectives of the Compressed Air Energy Storage (CAES) program are to establish stability criteria for large underground reservoirs in salt domes, hard rock, and porous rock used for air storage in utility applications, and to develop second-generation CAES technologies that have minimal or no dependence on petroleum fuels. During the year reported reports have been issued on field studies on CAES on aquifers and in salt, stability, and design criteria for CAES and for pumped hydro-storage caverns, laboratory studies of CAES in porous rock reservoris have continued.

Research has continued on combined CAES/Thermal Energy Storage, CAES/Solar systems, coal-fired fluidized bed combustors for CAES, and two-reservoir advanced CAES concepts. (LCL)

FLYWHEELS

REFER ALSO TO CITATION(S) 27425, 27426

27248 (DOE/ET/20279—92) **Residential photovoltaic flywheel storage system performance and cost.** Hay, R.D.; Millner, A.R.; Jarvinen, P.O. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract AC02-76ET20279. 6p. (CONF-800806—22). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

A subscale prototype of a flywheel energy storage and conversion system for use with photovoltaic power systems of residential and intermediate load-center size has been designed, built and tested by MIT Lincoln Laboratory. System design, including details of such key components as magnetic bearings, motor generator, and power-conditioning electronics, are described. Performance results of prototype testing are given and indicate that this system is the equal of or superior to battery and inverter systems for the same application. Results of cost and user-worth analysis show that residential systems are economically feasible in stand-alone and in utility-interactive applications.

27249 (DOE/ET/26931—T1) **Low-cost flywheel demonstration program. Final report.** (Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.). Apr 1980. Contract AC01-77ET26931. 109p. NTIS, PC A06/MF A01.

The Applied Physics Laboratory/Department of Energy Low Cost Flywheel Demonstration Program was initiated on 1 October 1977 and was successfully concluded on 31 December 1979. The total cost of this program was $355,190. All primary objectives were successfully achieved as follows: demonstration of a full-size, 1-kWh flywheel having an estimated cost in large-volume production of approximately $50/kWh; development of a ball-bearing system having losses comparable to the losses in a totally magnetic suspension system; successful and repeated demonstration of the low-cost flywheel in a complete flywheel energy-storage system based on the use of ordinary house voltage and frequency; and application of the experience gained in the hardware program to project the system design into a complete, full-scale, 30-kWh home-type flywheel energy-storage system.

27250 (SAND—79-7097) **Research and development for inertial energy storage based on a flexible flywheel. Final report.** Vance, J.M. (Texas A and M Univ., College Station (USA). Dept. of Mechanical Engineering). Jun 1980. Contract AC04-76-DP00789. 50p. NTIS, PC A03/MF A01.

A design concept for a non-rigid energy-storage flywheel suitable for home or farm use has been investigated at Texas A and M University under a Sandia Laboratories' contract. The distinguishing feature of this flexible flywheel is its construction from high strength fibers (such as synthetic rope) with no bonding agent. The work done to date indicates that the flexible flywheel is self-balancing, safe, has a high energy-density capability (60 Wh/lb), and should be simple and economical to manufacture. The major thrust of the contract work has been to find a solution to the subsynchronous whirling instability, a problem common to all high speed flywheels, which is especially severe in the flexible flywheel due to the high supercritical speed ratio and the large amount of internal friction. A unique gimbal support system has been designed and analyzed and tested on this contract which stabilizes the flywheel without the need for a squeeze film damper. The conceptual design was developed for a flexible flywheel energy storage system suitable for interfacing with a small-scale solar energy source. Cost estimates were prepared for the system in the 10 KWh and 50 KWh sizes.

27251 (SAND—79-7099) **Development of cellulose flywheel rotors. Final report.** Erdman, A.G.; Hagen, D.L.; Frohrib, D.A. (Minnesota Univ., Minneapolis (USA). Dept. of Mechanical Engineering). Mar 1980. Contract AC04-76DP00789. 105p. NTIS, PC A06/MF A01.

The primary tasks addressed were: the design and development of durable hub-to-rotor attachments and the balancing and vibrational analysis of the resulting hub-rotor systems; and measuring and analyzing the strength distributions and durabilities of different types of plywood and of hub-rotor systems. In accomplishing these tasks, a new metallic-hub to cellulosic-rotor bonding attachment was designed which utilizes a flexible scalloped metal-band in lieu of the traditional elastomeric layers to accommodate the differential strain between rotor and hub. A self-centering dynamic balancer was designed to automatically locate the inertial axis of a rotor. In analyzing rotor vibrations, a nondimensional design parameter was derived which correlates the support flexibility required to the useable strength and length of the rotor for a useful operating range above the transverse critical frequency. The tensile strengths of conventional Finnish birch plywood were measured in three directions using material equilibrated at 50% relative humidity and vacuum-dried material. Similar measurements of custom-made, hexagonal, yellow birch plywood showed double the mid-ply strengths. The standard deviation of the measured strengths and the drop in mean strength with vacuum drying were both on the order of 10%. High resolution (0.01%) microprocessor data acquisition equipment was assembled to monitor tensile tests. Digital circuitry was designed to monitor the acoustic emission energy with 65 db S/N ratio. Cyclic tensile fatigue test equipment was modified for the fatigue testing of plywood samples. A dynamic cyclic fatigue apparatus capable of simultaneously driving two rotors in separate vacuum containers at 10 kW was designed. A pseudodynamic hub-rotor fatigue tester was designed and built from existing flexural fatigue testing apparatus.

THERMAL

REFER ALSO TO CITATION(S) 27168, 27202, 27305, 27314

27252 (DOE/NASA/3184—1) **Heat storage in alloy transformations.** Birchenall, C.E. (Delaware Univ., Newark (USA)). Apr 1980. Contract AI01-77ET26945. 30p. (NASA-CR—159787). NTIS, PC A03/MF A01.

The status of an investigation to determine the feasibility of using metal alloys as thermal energy storage media is reported. The program currently has three major elements: (1) the identification of congruently transforming alloys and thermochemical property measurements, (2) the development of a precise and convenient method for measuring volume change during phase transformation and thermal expansion coefficients during heating and cooling, (3) the determination of materials that can be used to contain the metal alloys. The elements selected as candidate media were limited to aluminum, copper, magnesium, silicon, zinc, calcium, and phosphorus on the basis of low cost and latent heat of transformation. Several new eutectic alloys and ternary intermetallic phases have been determined. A new method employing x-ray absorption techniques was developed to determine the coefficients of thermal expansion of both the solid and liquid phases and the volume change during phase transformation from data that are obtained during one continuous experimental test. The method and apparatus are discussed and the experimental results are presented for aluminum and two aluminum-eutectic alloys. Candidate materials are being evaluated to determine suitable materials for containment of the metal alloys. Graphite has been used to contain the alloys during the volume change measurements. Silicon carbide has been identified as a promising containment material and surface-coated iron alloys are being considered. A system considerations that are pertinent if alloy eutectics are used as thermal energy storage media are discussed. Potential applications to solar receivers and industrial furnaces are illustrated schematically.

27253 (PNL—3322) **Seasonal thermal energy storage. Program progress report, April 1979-December 1979.** Minor, J.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1980. Contract AC06-70RL01830. 59p. NTIS, PC A04/MF A01.

The objective of the Seasonal Thermal Energy Storage (STES) Program is to demonstrate the economic storage and retrieval of thermal energy on a seasonal basis, using heat or cold available from waste sources or other sources during a surplus period to reduce peak period demand, reduce electric utilities peaking problems, and contribute to the establishment of favorable economics for district heating and cooling systems for commercialization of the technology. The initial thrust of the STES Program is toward utilization of ground-water systems (aquifers) for thermal energy storage. The program has the further objective of evaluating other methods of seasonal storage, both from existing literature and by following current work in other countries. The STES Program is divided into an Aquifer Thermal Energy Storage (ATES) Demonstration Task for demonstrating the commercialization potential of aquifer thermal energy storage technology using an integrated system approach to multiple demonstration projects and a parallel Technical Support Task designed to provide support to the overall STES Program, and to reduce technological and institutional barriers to the development of energy storage systems prior to significant investment in demonstration or commercial facilities. During this initial STES program reporting period, program plans were completed, and the Work Breakdown Structure, budget, schedules, and reporting/review procedures were developed. Responsibility was assumed for existing, ongoing STES contracts and projects.

CHEMICAL

REFER ALSO TO CITATION(S) 27552

BATTERIES

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 27128, 27255, 27420

27254 Advanced batteries for electric vehicles: a look at the future. Walsh, W.J. (Energy and Environment Systems Division of Argonne National Laboratory, Argonne, Illinois). *Phys. Today;* **33**: No. 6, 34-41(Jun 1980).

Improvements in lead-acid systems and successful developments in other chemical systems, including Ni/Fe, Ni/Zn, Li/FeS, Zn/Cl_2, and Na/S, may help reduce our dependence on liquid fuels.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 27419

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 27298

27255 (UCRL—15171) **Role of microcomputers in secondary battery development and testing.** Hollandsworth, R.P.; Adams, G.B. (Lockheed Palo Alto Research Labs., CA (USA)). 11 Dec 1979. Contract W-7405-ENG-48. 138p. (LMSC-D—681058). NTIS, PC A07/MF A01.

The development and application of a low-cost dedicated microcomputer system to secondary battery development and testing are described. An overview of computers, hardware, and software is given, and the particular application discussed is the zinc/ferricyanide hybrid redox battery. However, modifications are examined which then enable its use in other secondary battery test programs. The system is capable of controlling the charge and discharge cycles of six or more secondary batteries based upon five or more operator-determined cell parameters, and computing at the end of each cycle the voltaic, coulombic, and energy-conversion efficiencies for each cell. The system described fulfills the objective of enabling one person to control, collect, and interpret cyclic data from many cells with a minimum of effort. 20 figures, 38 tables.

APPLICATIONS

REFER ALSO TO CITATION(S) 27128

ENERGY MANAGEMENT AND POLICY

ENERGY MANAGEMENT AND POLICY

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 26834, 27273, 27282, 27302, 27331, 27341

27256 (BNL—27657) **Brookhaven process optimization models.** Pilati, D.A.; Sparrow, F.T. (Brookhaven National Lab., Upton, NY (USA). National Center for Analysis of Energy Systems). 1979. Contract AC02-76CH00016. 21p. (CONF-790455—7). NTIS, PC A02/MF A01.

From Joint national meeting of the Institute of Management Sciences and the Operations Research Society of America; New Orleans, LA, USA (30 Apr 1979).

The Brookhaven National Laboratory Industry Model Program (IMP) has undertaken the development of a set of industry-specific process-optimization models. These models are to be used for energy-use projections, energy-policy analyses, and process technology assessments. Applications of the models currently under development show that system-wide energy impacts may be very different from engineering estimates, selected investment tax credits for cogeneration (or other conservation strategies) may have the perverse effect of increasing industrial energy use, and that a proper combination of energy taxes and investment tax credits is more socially desirable than either policy alone. A section is included describing possible extensions of these models to answer questions or address other systems (e.g., a single plant instead of an entire industry).

27257 (IKE-K—54-20) **Simulation of the energy-industry-environment system for limited economic regions, using the example of Baden-Wuerttemberg. Part 1. Data, model development adaptation 1960 to 1974.** Hoecker, K.H.; Unger, H. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme). Oct 1979. 105p. (In German). NTIS (US Sales Only), PC A06/MF A01.

Following some general remarks on the task and function of systems analyses in society, on the project in the overall system energy-industry-environment, and on the goals of the project, model structure and methods are described. Part I of the final report gives an analysis of the past (1960 to 1974), and in particular of the structure and development of the Baden-Wuerttemberg power industry and compares these data with the data for West Germany. On the producer side, there are especially the electric power industry and the petroleum industry; on the consumer side, there are the usual sectors of private households and small consumers, industry and transportation. The development of the past power supply structure is analyzed, and the analysis is used as a basis for a forecast. Part II of this report will include development trends, scenarios, and model assumptions in forecasting the period 1975 to 2000.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 26887, 27257, 27267, 27316, 27323, 27331, 27336, 27337, 27340, 27366

27258 (BNL—27603) **Costing methodologies for energy systems.** Allentuck, J.; Mubayi, V.; Reisman, A.W. (Brookhaven National Lab., Upton, NY (USA). National Center for Analysis of Energy Systems). Nov 1979. Contract AC02-76CH00016. 23p. (CONF-791216—3). NTIS, PC A02/MF A01.

From Conference on long-term energy resources; Montreal, Canada (3 Dec 1979).

The ability to make comparisons of costs among energy sources and delivery systems is a sine qua non for long-term energy planning and for decision making in establishing research and development strategies. Such comparisons are especially difficult for new energy sources and innovative technologies. An additional dimension of complexity is added by the general failure of monetary costs to coincide with social costs. In this paper, the problem of devising a methodology for arriving at costs of such systems which may be used to compare alternative sources is addressed. The basic elements of such a methodology are examined, and such diverse subjects as resource-supply curves, experience and learning, and the cost of environmental pollution are investigated.

27259 (JPRS—75345(Exc)) **China report: economic affairs, No. 49.** 21 Mar 1980. Translation of various articles. 16p. NTIS.

Briefs from publications dealing with economic affairs in China are presented. The citations are entitled: Bank Loans; PRC Scientist Proposes Developing Nuclear Energy; Importance of Energy Resources Stressed; Three Chinese Colleges Score Success in Energy Conservation; Solar Energy Batteries Produced in Yunnan; Over 7000 Small Hydroelectric Power Stations Built in 1979; Daqing Scores Success in Oil Production Research; Henan Electricity; Yunnan Electricity Management; Hunnan Power Cable Project; NEI Monggol Coal Mine; Guizhou Mineral (antimony) Discovery; and Shaanxi Gold Deposits.

27260 (JPRS—75272(Exc)) **China report: economic affairs, No. 47.** 10 Mar 1980. Translation of various articles. 18p. NTIS.

Briefs from publications dealing with economic affairs in China are compiled. Titles of the briefs are: Discovery of Renqiu Oilfield in Central Hebei; Overview of Petroleum Production at Daqing; Oil Discovered in Northern Jiangsu, Coal in Anhui; Shaanxi Spring Festival Power Supply; PLA Energy Conservation Conference; Zhejiang Solar Energy Usage; Shanghai Power Generators; Offshore Petroleum Prospecting Bureau Fulfills Yearly Tasks Ahead of Time; and Zhejiang Dolomite Mine.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 27258, 27267

NATURAL RESOURCES

REFER ALSO TO CITATION(S) 27259, 27260, 27449

RESEARCH, DEVELOPMENT, DEMONSTRATION, AND COMMERCIALIZATION

27261 (FE—2468-65) **Basic research in engineering: process and systems dynamics and control. High priority research needs relevent to energy.** Rabins, M.J.; Edgar, T.F.; Richardson, H.H.; Zaborszky, J. (Wayne State Univ., Detroit, MI (USA); Texas Univ., Austin (USA).

Dept. of Chemical Engineering; Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Mechanical Engineering; Washington Univ., Seattle (USA)). Feb 1980. Contract EF-77-C-01-2468. 162p. NTIS, PC A08/MF A01.

At a workshop held in Denver, Colorado, on June 20 to 23, 1979, Process and Systems Dynamics and Control (PSDC) is concerned with the development and control of system behavior, performance criteria, and theories of control and optimization. This report presents a set of high-priority basic engineering research needs in the PSDC field which are important to the development of future energy technologies. The ten high priority generic research areas were aggregeted into four major research needs recommended for DOE support: on-line optimization and control, systems methodology, measurement methodology and instrumentation, and modeling.

27262 (FE—2468-66) **Basic research in engineering: process and systems dynamics and control. Proceedings of a workshop held in Denver, Colorado, June 20-23, 1979.** Rabins, M.J. (Wayne State Univ., Detroit, MI (USA)). Feb 1980. Contract EF-77-C-01-2468. 326p. NTIS, PC A15/MF A01.

Process and Systems Dynamics and Control (PSDC) is one of the high-priority areas in DOE's new Basic Research in Engineering program. Six application areas are covered by position papers and keynote talks in this volume: transportation, processes, manufacturing, energy conversion and delivery, environmental aspects, and other energy user groups (including water resources and agriculture). Seven panel topics are also discussed: optimization and management methodology, control theory and techniques, methodology and sensor technology, modeling and identification, microprocessor hardware and software, large-scale systems and socio-economic and institutional analysis, and system/human/computer interfaces. (DLC)

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 26966, 27023, 27024, 27025, 27226, 27227, 27229, 27230, 27231, 27232, 27239, 27276

27263 **Canada in the world power market.** *Mod. Power Eng.;* **73**: No. 1, 18-37(Jan 1979).

The role of Canadian exports in power projects and industrial development throghout the world is discussed in a series of regional articles. Sales of CANDU reactors in Argentina, South Korea and Romania are mentioned along with possible sales to Japan, China and Mexico. Other technologies, including telecommunications in the Middle East, copper smelters in Chile and pulp mills in Argentina are introduced as examples of Canadian exports. The impact of technology transfer throughout the Americas, Asia, Africa and Europe is stressed. Services available from Canadian government agencies such as the Export Development Corporation and the Canadian International Development Agency are described along wth international development agencies to illustrate the assistance available to the export market. The role of consultants in other projects is also described. (T.I.).

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 27249

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 27140, 27294, 27322, 27339

CONSERVATION

REFER ALSO TO CITATION(S) 27256, 27276, 27299, 27300, 27302, 27306, 27307, 27308, 27309, 27310, 27315, 27317, 27318, 27319, 27320, 27323, 27327, 27328, 27329, 27330, 27332, 27340, 27342, 27343, 27344, 27345, 27346, 27347, 27358, 27366, 27371, 27372, 27373, 27374

27264 (DOE/CS—0077) **Annual report to the President and the Congress on the State Energy Conservation Program for calendar year 1978.** (Department of Energy, Washington, DC (USA). Office of State and Local Programs). Feb 1979. 28p. NTIS, PC A03/MF A01.

Reported are the activities of the third year's operation from December 1977 through December 1978, of the State Energy Conservation Program. Included are discussions regarding estimates of the energy conservation achieved, the degree of state participation and achievement, and descriptions of innovative energy conservation programs undertaken by states. At the end of 1978, thermal and lighting energy efficiency standards had been authorized or adopted in 43 states and territories, and actions in another 2 states are pending. Government procurement policies met requirements in all but 3 states, and the public education program requirement has been met by all but 2 states. Those states which did not meet these requirements in 1978 have established action plans with milestones to assure full compliance in 1979. All states and territories have met requirements for the remaining mandatory measures programs to promote the availability and use of carpools and vanpools and right-turn-on-red after stopping.

27265 (DOE/CS/62122—01) **Study of State Energy Conservation Program: 1979 energy savings indicators.** (Price Waterhouse Co., Washington, DC (USA)). Jun 1980. Contract AC01-80CS62122. 63p. NTIS, PC A04/MF A01.

This study reviewed 1979 energy savings reports provided by states for conservation measures in four major categories of State Energy Conservation Program services, namely: (1) industrial, commercial, and institutional; (2) residential; (3) thermal and lighting; and (4) transportation. Conservation measures in these categories constitute a major portion of the total estimated 1980 savings for the State Energy Conservation Program. This study only addressed measures in these categories for which usable documentation had been submitted by states. Based on a review of measures supported by available documentation, the study estimates that energy savings associated with the conservation measures reviewed were 108 TBtu's for the calendar year 1979. These estimated energy savings for 1979 were converted into 540 million dollars for 1979 and 2.8 billion dollars over the projected life of the conservation measures.

27266 (LBL—10896) **International comparison of residential gas use and conservation.** Schipper, L.; Ketoff, A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1980. Contract W-7405-ENG-48. 21p. (CONF-800642—3). Dep. NTIS, PC A02/MF A01.

From International gas research conference; Chicago, IL, USA (9 Jun 1980).

A detailed study of the use of gas in households in several countries has compiled much data on the use of gas. The present discussion focuses on the factors that influence quantities of gas used, such as economic and lifestyle indicators, ownership of equipment, energy intensity of equipment use, gas prices, and conservation potentials. Detailed comparisons of gas use among countries over time are possible. It is suggested that a great potential for more efficient use of gas exists.

27267 (PNL-RAP—39) **Potential social, institutional, and environmental impacts of selected energy-conservation measures in two Washington communities.** Edelson, E.; Olsen, M. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1980. Contract EY-76-C-06-1830. 95p. NTIS, PC A05/MF A01.

The likely environmental, social, and institutional impacts of selected energy-conservation measures in two communities in Washington state are reported. The five conservation measures investigated in this study were: (1) retrofitting existing buildings; (2) district heating and Integrated Community Energy Systems (ICES); (3) small automobiles and vehicle redesign; (4) land-use and housing modifications; and (5) electric-utility rate reform. Twenty potential impact areas were selected for analysis. These areas were divided into five categories of environmental impacts, economic impacts, community impacts, personal impacts, and overall quality of life in the community. The research was conducted in Seattle and Yakima, Washington. In each location, about two dozen public officials and business, labor, and community leaders were interviewed. Their diverse views are summarized. The Seattle respondents saw energy conservation as a highly desirable policy with a number of temporary, transitional problems arising as energy-conservation measures were implemented. Yakima respondents, in contrast, did not expect to encounter many serious energy problems in the foreseeable future and consequently viewed energy conservation as a relatively minor community concern. Moreover, they anticipated that many conservation measures, if implemented by the government, would encounter either apathy or resistance in their community. Two broad generalizations can bedrawn from these interviews: (1) energy conservation will basically be beneficial for the natural environment and our society; and (2) if energy conservation does become a dominant thrust in our society, it could stimulate and reinforce a much broader process of fundamental social change. (LCL)

27268 **Building energy-conservation efforts in Iowa.** Reynolds, G. (Iowa State Univ., Ames). pp 6p, Paper 2 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

Iowa's Class A Energy Audit program is traced as it developed and was integrated into a total state plan. The formation of a building-information data base, creation of a management organiza-

tion, development of implementation procedures, and steps taken to integrate these separate state and Federal programs into a comprehensive state plan are discussed. 4 references, 4 figures.

27269 Department of Energy Weatherization Assistance Program. pp 5p, Paper 9 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The Weatherization Assistance Program provides funds to make low-income homes more energy-efficient. Funds are channeled through state, local, and volunteer organizations to purchase materials and labor. Eligibility requirements and audit procedures are summarized. A sample Building Check and Job Order Sheet is attached. (DCK)

27270 National Energy Conservation Policy Act of 1978 (P. L. 95-619): based upon final rule. pp 17p, Paper 11 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The National Energy Conservation Policy Act of 1978 allocates $900 million to state energy offices to identify conservation possibilities and implement appropriate measures that will reduce energy use in buildings. A four-step procedure for participating in the matching grant program for schools and hospitals begins with a preliminary audit and is followed by a walk-through energy audit, technical assistance, and the purchase and installation of equipment. Eligibility requirements, the purposes of the grants, information requirements, who perform the preliminary audit, and what assistance is provided are outlined for each step. (DCK)

27271 Oregon's experience: legislative and regulatory energy-management incentives. Gray, L. (Oregon Department of Energy, Salem). pp 6p, Paper 22 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The Oregon Department of Energy has focused on a program of free energy audits which electric and gas utilities are required to perform for customers of each sector and on building codes setting thermal and lighting efficiency. Aggressive new programs will explore the conservation potential of renewable energy sources and recommend programs for achieving the potential. The proposals will require a commitment from taxpayers and consumers, which will introduce political factors. (DCK)

27272 Present state and future potentials of energy conservation in Japan. Iseda, Y. (Inst. of Energy Economics, Tokyo, Japan). pp 8p, Paper 24 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The energy-conservation problem is not only related to the technological and economic facets but also closely to the economic and social structures and the people's-value concept. One structural feature of energy consumption in Japan is, however, that the weight of the industrial sector in national energy consumption is high compared with other industrial countries. The actual state of energy conservation in several typically energy-intensive industries was examined and quantitative analyses were attempted, whenever possible, of the possibilities of energy conservation for the period up to 1985. Japan's potentials for reducing energy consumption 12.1% below 1973 levels seem hopeful if the present energy strategy is followed, and the importance of investment is emphasized. 12 figures, 4 tables.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 26904, 27258, 27277, 27278, 27279, 27280, 27282, 27301, 27325

27273 (BNL—26987) **Reference Energy Systems as applied to regional energy policy.** Hermelee, A. (Brookhaven National Lab., Upton, NY (USA). National Center for Analysis of Energy Systems). Dec 1979. Contract EY-76-C-02-0016. 26p. (CONF-800803—1). NTIS, PC A03/MF A01.

From 14. intersociety energy conversion engineering conference; Boston, MA, USA (5 Aug 1980).

Portions of document are illegible.

Reference Energy Systems (RES) have been developed for the region serviced by the Tennessee Valley Authority (TVA) for a base time period and projections developed for the years 1985 and 2000. This systems formulation has traditionally been applied to the assessment of energy technologies and policies on a national level. This paper presents a reformulation of the projection methodology in order to apply the RES format on a regional level. The RES is a network representation of the technical activities required to supply various forms of energy to end-use activities. Technologies are defined for all operations involving specific fuels including resource extraction, refinement, conversion, transportation, distribution, and utilization. The impact of a new technology in terms of resource consumption may be evaluated by modifying the energy-flow paths in a region to incorporate the new technology. Alternate paths through the network reflect the substitutability of resources and technologies for one another.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 26889, 26905, 26906, 27264, 27269, 27317, 27366, 27448

27274 (DOE/TIC—11204) **Energy action program for state legislators: a report on the National Legislative Town Meeting on energy.** Turner, D.A. (ed.). (Department of Energy, Washington, DC (USA)). Jul 1980. 92p. NTIS, PC A05/MF A01.

Since December 1979, the DOE Office of Intergovernmental Affairs has coordinated an action program with key energy-oriented State legislators throughout the nation. This effort, which involves 151 legislators and several components of DOE, began at the National Legislative Town Meeting on Energy held in Denver, CO December 17-19, 1979. This report summarizes the program and includes highlights of the Denver meeting. The meeting was conducted to assure that State legislative views on federal energy policy are effectively noted, and to encourage State legislators to introduce, support, and enact Federal energy policies and initiatives in their respective legislatures. Specifically, sections are devoted in this report to: the Roles of State Governments (excerpts from 3 speakers); Energy and Economics (excerpts from 4 speakers); and General Session Speeches (3 excerpts). Also included are: Town Meeting Evaluation (by participants); thumbnail sketches of DOE Regional Representatives; DOE Regional Map; List of Participants (with thumbnail sketches); and Resource Material/Contacts.

27275 Legislation and regulation in Maine. pp 8p, Paper 8 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

Energy-related legislation in Maine emphasizes consumer incentives and technical assistance programs. A summary of the major provisions of legislation passed in the last three sessions covers six regulatory, five educational, and five incentive Acts. Regulation is introduced only when necessary. A positive relationship has developed between the State Office of Energy Resources and the State Legislature. (DCK)

27276 National Energy Plan: success hinges on cooperation. Savitz, M. (DOE, Washington, DC). *Spec. Eng.;* **41**: No. 6, 74-79(Jun 1979).

The author defines the National Energy Plan and stresses the need for cooperation of the engineering profession to make it successful. It is emphasized that about 65 percent of the current building stock in the United States will be in use in the year 2000. We must retrofit these buildings with energy-conservation equipment because over 40 percent of the energy they consume is wasted. Over 27 billion sq ft of existing commercial space and 76 million existing residential units were designed and built in an era of inexpensive and readily available energy. Federal funds are available to finance architect/engineer services related to the energy retrofit of schools, hospitals, local government and public care buildings. New building design offers even more opportunities for energy-efficient design. Because of the large potential impact efficient design of new buildings could have, the Department of Energy (DOE) is developing mandatory Building Energy Performance Standards (BEPS) for new construction. Thirty-five percent of the buildings in the year 2000 will have been constructed in the 1980's and 1990's. Solar heating and cooling with both passive and active systems presents one of the most promising supply alternatives to fossil fuels. But without the interest of the engineering profession, DOE cannot expect the nation to expand its use of solar technology in buildings. Graphs are shown of estimates of future fuel savings (1985 to 2020), and projections of energy use by energy source in 1985, 2000, and 2020.

FOSSIL FUELS

REFER ALSO TO CITATION(S) 27684

COAL

REFER ALSO TO CITATION(S) 26796, 26817

PETROLEUM

REFER ALSO TO CITATION(S) 26834, 26835, 26884, 26887, 26889, 26905

27277 (DOE/RA/0042—1) **Petroleum supply alternatives for the Northern Tier and inland states through the year 2000. Vol. I. Executive summary and findings.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Resource Applications). 31 Oct 1979. 313p. NTIS, PC A14/MF A01.

The Northern Tier states are being affected by a continued decline in domestic crude oil supplies. This condition will be exacerbated by the expected curtailment of Canadian crude oil exports in the early 1980s. This report presents the findings of an interdisciplinary team from the Department of Energy (DOE) concerning (1) petroleum supply needs and (2) alternatives to alleviate potential crude shortages in the northern tier and inland states through the year 2000. The report is in response to a Department of Interior (DOI) request for an assessment of proposed new pipeline systems to serve these areas to be made part of an Environmental Impact Statement (EIS). The findings also provide an analytical basis upon which the President may select a crude oil transportation alternative or alternatives for expedited treatment in the Federal permitting process. The report reviews the west coast ANS surplus and the current capability of refineries in Northern Tier states to process Alaska North Slope (ANS) crude oil. It also takes into account such related factors as potential crude shortages and the feasibility of reversing, expanding, or converting existing pipelines. The possibility of continued Canadian crude oil exchanges and historic sales, and the impact of large volumes of Mexican crude oil on the US market, are discussed. The report also includes a comparative energy use analysis.

27278 (DOE/RA/0042—2) **Petroleum supply alternatives for the Northern Tier and inland states through the year 2000. Vol. II. Appendices.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Resource Applications). 31 Oct 1979. 366p. NTIS, PC A16/MF A01.

Petroleum supply needs in the northern tier states and alternatives for alleviating potential crude shortages through the year 2000 are summarized. Specific topics in this appendix include: alternative crude oil transportation systems; hearings; demand forecast analysis for the Northern Tier and inland states; major crude oil piplines in the United States; refinery capacities; impact of Mexican crude oil exportation on Gulf Coast Refineries and Alaskan North Slope crude oil; transportation proposals; energy use comparisons of Title V proposals; and existing petroleum product pipeline capacities to adjacent states. (DC)

27279 (LA—8383-MS) **Emergency planning for the Persian Gulf.** Teller, E. (Los Alamos Scientific Lab., NM (USA)). Jun 1980. Contract W-7405-ENG-36. 20p. NTIS, PC A02/MF A01.

This was a talk given by Edward Teller for the LAMPF Users Group, Inc. The subjects discussed included: the SALT Treaty, military strengths of the USSR and USA, civil defense preparedness, the present Iranian-Afghanistan situations, and the possibility that the USSR will gain control of the mid-east oil industry. He suggested the following possibilities in preparing for the latter situation: the synthesis of oil from wood; the use of Alaskan coal by coal-slurry transport; the use of metha-coal; the use of in-situ coal gasification; the use of wind power; and the use of nuclear power. Several innovations currently underway in the state of Washington under the direction of Governor Dixie Lee Ray are pointed out. (DC)

27280 (UCRL—52000-80-6, pp 19-27) **Suppose the oil stops...** Jun 1980.

In Energy and technology review.

Continued turmoil in the Middle East makes a complete cutoff of imported oil supplies from that region a possibility that must be considered. If a major oil cutoff occurred, it would cause disastrous short-and mid-range consequences to our economy. Drastic conservation measures would help to stretch the remaining supplies but only enough to cover about half of the shortfall. Efforts to produce significant effects by introducing other energy technologies and supplies involve long lead times and therefore cannot be effective in the short term. Foresight and initiative will be required if we are to develop effective coping strategies beforehand. Our purpose in this article is to estimate the magnitude of the maximum shortfall, to identify the major short-term actions possible in response to such a crisis, and to point out some longer range actions to complete our recovery.

NATURAL GAS

REFER ALSO TO CITATION(S) 26835, 26896, 26897, 26904, 26906, 26907

27281 (DOE/EIA—0167(78)) **Gas supplies of interstate natural gas pipeline companies, 1978.** Pappas, T.A. (Department of Energy, Washington, DC (USA). Energy Information Administration). Apr 1980. 72p. NTIS, PC A04/MF A01.

This report on the gas supplies of interstate natural gas pipeline companies for caldendar year 1978 is the fifteenth report on the gas supplies of these companies. Total dedicated domestic gas reserves owned and controlled by interstate pipeline companies increased in 1978 by 1.1 trillion cubic feet, or 1.2 percent, from 92.9 trillion cubic feet at the beginning of the year to 94.0 trillion cubic feet at the end of the year. Total interstate reserve additions during 1978 were nearly 8.4 trillion cubic feet, compared with additions at 5.8 trillion cubic feet for 1977. The total net additions and revisions to reserves during 1978 was 12.0 trillion cubic feet. In this report this figure is also referred to as gross change in reserves. Only when the total net of additions and revisions is greater than production is the volume of reserves increased. This is the first time that the total of additions and revisions is greater than the production since 1967 and is also the largest positive change since that year. Total gas purchased and produced from the dedicated domestic gas reserves is approximately the same as in 1977, 10.9 trillio cubic feet. The 1978 R/P ratio for the total domestic reserves and production was 8.7 as compared with the 1977 ratio of 8.5. This ratio has been declining throughout the fifteen year history of Form 15 reports. The ratio of gross change in reserves (revisions and additions) to production for 1978 was 1.10. For 1977 the comparable ratio was 0.51. When this ratio is less than unity, year-end reserves for that year will be less than the previous year. This ratio has exceeded unity for the first time since 1967.

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 27109

ELECTRIC POWER

REFER ALSO TO CITATION(S) 27319

27282 (BNL—27816) **Linear-programming approach to electricity demand-curtailment planning.** Allentuck, J.; Carroll, O.; Schnader, M. (Brookhaven National Lab., Upton, NY (USA). National Center for Analysis of Energy Systems). May 1980. Contract AC02-76CH00016. 53p. (CONF-800571—2). NTIS, PC A04/MF A01.

From Canadian Operations Research Society meeting; Quebec, Canada (20 May 1980).

Curtailment planning at a generally rudimentary level has been undertaken by the governments of some twenty states. Many utilities have demand-curtailment plans, however, these are often incorporated in plans for meeting capacity shortages. In at least five states, there are apparently no curtailment plans either at the state-government level or at the utility level. Moreover, none of the existing electricity demand curtailment plans examined included an explicit statement of the planners' objective in arriving at a specified sharing of the burdens of curtailment among consumer classes. Yet clearly the actual allocations of such burdens will affect the cost of the shortage. Since a study of state planning failed to yield a clear-cut indication of which of many possible curtailment allocation schemes would best serve as a point of departure for the design of an optimal curtailment strategy to deal with prolonged supply deficiencies, it was then decided to use a linear-programming approach. The advantages of such an approach are examined first, after which some important conceptual and practical problems in the design of a specific linear-programming model are addressed. A mathematical statement of the model is then followed by a brief review the principal methodological shortcomings of the linear-programming approach. Finally, the authors discuss how the analysis might be expanded to account for inter-regional and other secondary effects of curtailment.

27283 (DOE/RG—0036) **Electric power supply and demand for the contiguous United States, 1980-1989.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). Jun 1980. 651p. NTIS, PC A99/MF A01.

A limited review is presented of the outlook for the electric power supply and demand during the period 1980 to 1989. Only the adequacy and reliability aspects of bulk electric power supply in the contiguous US are considered. The economic, financial and environmental aspects of electric power system planning and the distribution of electricity (below the transmission level) are topics of prime importance, but they are outside the scope of this report.

ELECTRIC POWER GENERATION

27284 (CONS—8138-T3) **Powerplant Productivity Improvement Study: historic performance of Illinois investor-owned electrical-generating units. Final report, Project 2, Task 1.** (Illinois Commerce

Commission, Springfield (USA)). 4 May 1979. Contract FC01-77RG08138. 92p. NTIS, PC A05/MF A01.

In this task the historical performance of powerplants in Illinois was examined and the opportunities for improved powerplant productivity in Illinois was determined. The four utilities considered were the major investor-owned electric generating utilities in Illinois, i.e., Central Illinois Light Co., (CILCO), Central Illinois Public Service (CIPS), Commonwealth Edison (CECO), and Illinois Power (IP). The major findings are: (1) for evaluation purposes, the equivalent availability was judged to be the most-appropriate measure; (2) in terms of powerplant productivity, IP is among the best in the nation and, in terms of productivity from large coal units, it ranks in the top five nationally; (3) in general, the performance of coal-fired units of CILCO and CECO have been below national averages and in some cases, significantly below; (4) a review of the trends in production of all Illinois units reveals that Illinois units as a group have been generally below national averages for the respective unit classes; (5) as noted in this and other studies, productivities of the nuclear plants in Illinois have been below the national average for all comparable nuclear plants; and (6) this analysis should be updated when national 1977 and 1978 Edison Electric Institute data become publicly available.

27285 (CONS—8138-T5) **Powerplant Productivity. Improvement Study: current practices in Illinois utilities towards powerplant productivity. Final report, Project 1, Task 1.** (Illinois Commerce Commission, Springfield (USA)). 5 Apr 1979. Contract FC01-77RG08138. 103p. NTIS, PC A06/MF A01.

Efforts of this task indicate that powerplant productivity is a complex issue that has to take into account economic factors, equipment limitations, and system-loading characteristics as well as external constraints such as regulatory requirements. Among the specific findings are: (1) utilities in Illinois use the industry-wide measures of performance such as capacity factor, availability factor, forced outage rates etc.; equivalent availability as a measure is not in common practice; (2) several unit performance statistics are collected on a routine basis such as the daily unit status, component outage data, monthly production figures etc.; (3) identifying major causes of lost productivity appears to be a relatively simple task, but finding economically and technically acceptable corrective actions are generally more difficult; (4) selection of improvement projects, as well as evaluating their future impacts, is mostly based on operating experience and engineering judgement, with no use of formal analytical/statistical models; (5) there generally is a group in every utility - typically called the power production department - with routine responsibilities for upkeep of unit productivity; and (6) recently the Commonwealth Edison Co. has developed a procedure for utilizing the Edison Electric Institute outage data base for analyzing productivity-related questions at nuclear plants; this procedure utilizes unit nonoperating hours to measure productivity.

27286 (CONS—8138-T6) **Powerplant Productivity Improvement Study: project summary report.** (Illinois Commerce Commission, Springfield (USA)). 21 Dec 1979. Contract FC01-77RG08138. 82p. NTIS, PC A05/MF A01.

Key findings from the Illinois Powerplant Productivity Improvement Study are: (1) the historic performance (equivalent availability) of large generating units in Illinois is below national average performance; (2) cost-effective opportunities to improve performance exist, and utilities pursue many of these; (3) there are no strong regulatory disincentives to the undertaking of productivity improvement projects, but no strong incentives either; (4) current utility practices, procedures, and management philosophy toward improved productivity are being strengthened; (5) areas in which immediate attention is warranted include application of reliability engineering tools to the analysis of powerplant availability and more vigorous pursuit of opportunities for performance improvements; (6) DOE systematic methodology for analysis of productivity improvement projects was demonstrated at three units and found to be useful; (7) the potential for improved productivity was estimated to be of the order of 2% in planned and forced outage rates; (8) if a 5% improvement were to be attained, cumulative (through 1990) constant-dollar benefits would be approximately $500 million; (9) formula regulatory incentive mechanisms are presently in a developmental or experimental phase, but adoption by the State of Illinois does not appear warranted at this time; and (10) the Illinois Commerce Commission can encourage improved productivity by explicitly considering recent unit performance during normal rate-case proceedings.

27287 (CONS—8138-T7) **Powerplant Productivity Improvement Study: benefits of improved powerplant reliability. Final report, Project 2, Task 2 .** (Illinois Commerce Commission, Springfield (USA)). 5 Jun 1979. Contract FC01-77RG08138. 46p. NTIS, PC A03/MF A01.

A summary of total cumulative fuel consumption differences by fuel type through 1990 for four improvement scenarios is presented for Commonwealth Edison Company (CE) and for Illinois Power Company (IP). In all scenarios, liquid-fuel consumption is reduced. Generation is shifted to the coal and/or nuclear units for which improved availability has been assumed. For a 2% improvement in both planned (POR) and forced outage rates (FOR), a total of more than 16 million barrels of No. 6 oil will have been saved by 1990 by the two companies. This is the result of improving 10,894 MW on the CE system and 2234 MW on the IP system. For the two utilities combined, gross savings (in 1978 dollars) range from $83 million for a 1% POR improvement to $346 million for 2% improvements in both POR and FOR. In terms of their effect on ratepayers, these savings would be even greater since gross receipt taxes and other charges would be applied to a smaller-generation cost base under the improvement scenarios. Caution must be exercised however, since results do not take into consideration the costs of achieving the improved performance. The proportion of net benefits that would be passed on to ratepayers is largely dependent upon whether the utility is earning its allowed rate of return, and the frequency of rate-case filings. It was determined by both utilities that none of the improvement scenarios would lead to deferment of any planned capacity additions by 1990.

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION

27288 (EPRI-EL—1198(Vol.3)) **Research into load forecasting and distribution planning. Final report.** Northcote-Green, J.E.D.; Cummings, A.B.; Wall, D.L.; Merrell, C.J.; Fredley, J.M.; Bishop, D.; Lundstrom, H.; George, M. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Systems Technology Div.; Salt River Project, Phoenix, AZ (USA)). Apr 1980. 248p. NTIS, PC A11/MF A01.

A survey of the utility industry was conducted in an endeavor to discover existing power distribution planning models that could be integrated into a Global Distribution Planning Model. A secondary survey to identify the extent and availability of Feeder Analysis Programs is also described. The limited success of the first survey results in a redefinition of the planning program. A unified approach to distribution planning is described which is embodied in a Unified Distribution Planning Model (UDPM). The UDPM consists of two basic models, a Fixed Time Optimum Model for the development of different system configurations at any time instant and a Dynamic Optimum Model to link these different configurations over the planning period to produce an optimum long-term system expansion. To enable the application of optimization methods the Fixed Time Optimum Model is further divided into four submodels: substation sizing model; transfer model; feeder model; and substation location model. The UDPM is applied to the western region of the Salt River Project to demonstrate its practicality and usefulness in a utility environment.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 27288, 27304

UNCONVENTIONAL SOURCES AND POWER GENERATION

SOLAR

REFER ALSO TO CITATION(S) 27063, 27140, 27189, 27276

27289 **SERI Information Data Bank Network.** Ubico, R.E. (Solar Energy Research Inst., Golden, CO). pp 4p, Paper 21 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The availability of accurate, timely information will be an important key in the continued spread of solar energy. The products and services are described that are currently available through the Solar Energy Information Data Bank (SEIDB), a national information network developed and operated by the Solar Energy Research Institute (SERI), with the participation of member organizations. The SEIDB network will play a key role in the nation's transition to renewable energy sources during the 1980s.

GEOTHERMAL

REFER ALSO TO CITATION(S) 27185

OTHER

REFER ALSO TO CITATION(S) 27189, 27190, 27448

ENERGY CONVERSION

ENERGY CONVERSION

MHD GENERATORS

DESIGN AND DEVELOPMENT

27290 (CONF-800617—6) **Optimization of disk generator performance for base-load power plant systems applications.** Teare, J.D.; Loubsky, W.J.; Lytle, J.K.; Louis, J.F. (Massachusetts Inst. of Tech., Cambridge (USA)). 1980. Contract AC01-79ET15518. 10p. NTIS, PC A02/MF A01.

From 7. international conference on MHD electrical power generation; Cambridge, MA, USA (16 Jun 1980).

Disk generators for use in base-load MHD power plants are examined for both open-cycle and closed-cycle operating modes. The OCD cases are compared with PSPEC results for a linear channel; enthalpy extractions up to 23% with 71% isentropic efficiency are achievable with generator inlet conditions similar to those used in PSPEC, thus confirming that the disk configuration is a viable alternative for base-load power generation. The evaluation of closed-cycle disks includes use of a simplified cycle model. High system efficiencies over a wide range of power levels are obtained for effective Hall coefficients in the range 2.3 to 4.9. Cases with higher turbulence (implying β/sub eff/ $\leqq$ 2.4) yield high system efficiencies at power levels of 100 to 500 MW/sub e/. All these CCD cases compare favorably with linear channels reported in the GE ECAS study, yielding higher isentropic efficiences for a given enthalpy extraction. Power densities in the range 70 to 170 MW/m^3 appear feasible, leading to very compact generator configurations.

27291 (EPRI-AP—1316) **Open-cycle MHD systems analysis. Final report.** Lippert, T.E.; Weeks, K.D. (Westinghouse Electric Corp., Pittsburgh, PA (USA)). Feb 1980. 511p. NTIS, PC A22/MF A01.

Five variant configurations of a coal-burning open-cycle magnetohydrodynamic electric power generating facility were studied for evaluation as candidate first-generation power plants. A material and energy balance and cycle analysis was performed for each case to provide information for the conceptual designs and costing of all major MHD-related components and subsystems as well as specification of other state-of-the-art components. An economic comparison was made of each design by developing the cost-of-electricity based on component costs, estimates of operation and maintenance requirements and the performance of each plant from the system analyses. An overall description of each plant is provided along with discussions of critical component and process development. An oxygen-enriched OCMHD plant design was identified as an attractive candidate for first-generation utility service. This plant design appears to offer competitive costs of electricity and minimizes development risk.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 27290

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 27041, 27292

DUCT ENGINEERING AND FLUID DYNAMICS

27292 (FE—2248-24) **Development, testing and evaluation of MHD materials and component designs. Final report.** Sadler, J.W.; Bein, J.; Black, D.L. (Westinghouse Electric Corp., Pittsburgh, PA (USA)). Jun 1979. Contract EX-76-C-01-2248. 108p. NTIS, PC A06/MF A01.

Progress is reported in the following areas: (1) cooperative US/USSR MHD program; (2) Westinghouse MHD test facility (MHD duct development); (3) electrode and insulator materials development; (4) Westinghouse Electrode System Test Facility (WESTF); and (5) project management and documentation. (WHK)

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 27039

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 27470

FUEL CELLS

REFER ALSO TO CITATION(S) 27245

27293 (COO—1545-T1) **Handbook of fuel cell performance.** Benjamin, T.G.; Camara, E.H.; Marianowski, L.G. (Institute of Gas Technology, Chicago, IL (USA)). May 1980. Contract EC-77-C-03-1545. 141p. NTIS, PC A07/MF A01.

The intent of this document is to provide a description of fuel cells, their performances and operating conditions, and the relationship between fuel processors and fuel cells. This information will enable fuel cell engineers to know which fuel processing schemes are most compatible with which fuel cells and to predict the performance of a fuel cell integrated with any fuel processor. The data and estimates presented are for the phosphoric acid and molten carbonate fuel cells because they are closer to commercialization than other types of fuel cells. Performance of the cells is shown as a function of operating temperature, pressure, fuel conversion (utilization), and oxidant utilization. The effect of oxidant composition (for example, air versus O_2) as well as fuel composition is examined because fuels provided by some of the more advanced fuel processing schemes such as coal conversion will contain varying amounts of H_2, CO, CO_2, CH_4, H_2O, and sulfur and nitrogen compounds. A brief description of fuel cells and their application to industrial, commercial, and residential power generation is given. The electrochemical aspects of fuel cells are reviewed. The phosphoric acid fuel cell is discussed, including how it is affected by operating conditions; and the molten carbonate fuel cell is discussed. The equations developed will help systems engineers to evaluate the application of the phosphoric acid and molten carbonate fuel cells to commercial, utility, and industrial power generation and waste heat utilization. A detailed discussion of fuel cell efficiency, and examples of fuel cell systems are given.

27294 (DOE/CS—0156) **Batteries, fuel cells, and related electrochemistry: books, journals, periodicals, and other information sources, 1950-1979.** Chudacek, R.C. (Aerospace Corp., Los Angeles, CA (USA)). Apr 1980. Contract AI01-79ET25204. 56p. NTIS, PC A04/MF A01.

The materials listed have been divided into nine categories. The first section contains entries under the category headings of Batteries, Fuel Cells, Related Electrochemistry (Related denotes entries containing anything relating to battery or fuel cell electrochemistry), and Reference and Serialized Texts. The entries are listed in alphabetical order according to author. The second section contains a Keyword Index of all the entries in the Author Index. The third section consists of alphabetical listings of entries in the remaining five categories (Meetings, Abstracts, Journals, Newsletters, and Periodicals). The list does not include status, progress, or final reports on battery and fuel cell research and development programs, proceedings of special meetings or workshops, technical or scientific papers, or journal and periodical publications articles, nor does it include material published in foreign languages.

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 27255

27295 (BNL—51144) **Fuel cell applied research: electrocatalysis and materials. Quarterly report, January 1-March 31, 1979.** Srinivasan, S.; Isaacs, H.S.; McBreen, J.; O'Grady, W.E.; Olender, H.; Olmer, L.J.; Taylor, E.J. (Brookhaven National Lab., Upton, NY (USA)). Oct 1979. Contract AC02-76CH00016. 64p. NTIS, PC A04/MF A01.

In situ regeneration of surface areas of sintered carbon supported platinum electrodes in 85% H_3PO_4 at 150°C was studied. The kinetics of oxygen reduction on platinum in trifluoromethane sulfonic acid was investigated. Overpotentials in solid oxide electrolyte fuel cells were studied. Results are presented and discussed. Also, a survey of the status of studies of phosphoric acid and molten carbonate fuel cells is described. (WHK)

27296 (BNL—51158) **Fuel cell applied research: electrocatalysis and materials. Quarterly report, April 1-June 30, 1979.** Srinivasan, S.; Isaacs, H.S.; McBreen, J.; O'Grady, W.E.; Olender, H.; Olmer, L.J.; Schouler, E.J.L.; Yang, C.Y.; Taylor, E.J. (Brookhaven National Lab., Upton, NY (USA)). Jan 1980. Contract AC02-76CH00016. 62p. NTIS, PC A04/MF A01.

Topics studied include: (1) oxygen reduction and cyclic voltammetry on carbon supported platinum electrodes in 85% H_3PO_4; (2) oxygen reduction on platinum in 85% H_3PO_4 with small additions of trifluoromethane sulfonic acid or trifluoracetic acid; (3) overpotential characteristics of electrodes at interfaces with solid oxide electrolytes; and (4) oxygen diffusion through interconvection material in high temperature solid electrolyte fuel cells. Also, studies of phosphoric acid and molten carbonate fuel cell technologies are surveyed. (WHK)

27297 (EPRI-EM—1328) **Advanced Technology Fuel Cell Program. Annual report.** Bett, J.A.S.; Bushnell, C.L.; Buswell, R.F.; Gruver, G.A.; King, J.M.; Kunz, H.R. (United Technologies Corp., South Windsor, CT (USA). Power Systems Div.). 1980. 116p. NTIS, PC A06/MF A01.

Efforts were undertaken to establish a basis for the engineering development of an improved fuel cell power plant. These focused on molten carbonate fuel cells, advanced reformers, and use of coal products. Molten carbonate cell configurations were developed that are capable of enduring thermal cycles and were demonstrated in square-foot stacks of 8 and 20 cells. Subscale cells were tested at pressures of up to 5 atmospheres with little, if any, carbon or methane formation in the fuel cell. In addition, an adiabatic, a hybrid, and a cyclic reformer were evaluated.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 27297

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 27255, 27295, 27296, 27297

27298 (DOE/ET/25502—1) **Oxygen electrodes for energy conversion and storage. Annual report, 1 October 1977-30 September 1978.** (Diamond Shamrock Corp., Painesville, OH (USA)). 15 Jan 1980. Contract AC02-77ET25502. 362p. NTIS, PC A16/MF A01.

Research on the development of high performance, long life O_2 cathodes for both alkaline and acid electrolytes for a spectrum of applications including industrial electrolysis, fuel cells, and metal-air batteries is described. Oxygen electrocatalysts studied include platinum, silver, underpotential deposited layers and alloy metal layers on noble metal substrates, intercalated graphite, transition metal macrocyclic complexes, and transition metal oxides. Research on gas fed electrodes is also described. Results are presented and discussed in detail. An appendix on the electrodeposition of platinum crystallites on graphite substrates is included. (WHK)

APPLICATIONS

REFER ALSO TO CITATION(S) 27140

ELECTROCHEMISTRY, MASS TRANSFER, AND THERMODYNAMICS

REFER ALSO TO CITATION(S) 27295, 27296

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 27264, 27265

27299 (DOE/CS—0159/1) **State Energy Conservation Program measure directory sourcebook. Volume 8. Part 1 of 2 Books.** (Department of Energy, Washington, DC (USA). Office of State and Local Programs). May 1980. 526p. NTIS, PC A23/MF A01.

DOE has prepared an 8-volume Sourcebook to provide information to States which could be helpful to them in the development and implementation of their Energy Conservation Plans. The purpose of Volume 8, a 2-book set, is to facilitate exchange of information among States concerning program measures of common interest. It contains an abstract of information about each program measure in each State plan, including the name, telephone, and address of a contact person. This is intended to be the basic reference document for summary information on the 1979 State Plans.

27300 (DOE/CS/40178—01(Vol.1)) **Relevance of the second law of thermodynamics to energy conservation.** (General Energy Associates, Cherry Hill, NJ (USA)). Jan 1980. Contract AT01-79CS40178. 37p. NTIS, PC A03/MF A01.

An analysis is presented of the potential relevance of the use of analytical tools based on the Second Law of thermodynamics to existing federal programs for energy conservation in the industrial, transportation, buildings, and utility sectors in the US. (LCL)

27301 (ORO—5633-T1) **Alabama focus on energy.** Sauser, L.D. (Alabama Energy Management Board, Montgomery (USA); Auburn Univ., AL (USA). Office of Public Service and Research). Jan 1979. Contract FG05-77ER05633. 106p. NTIS, PC A06/MF A01.

A review of the energy situation in Alabama with respect to the production and consumption of several major types of energy, including coal, oil, natural gas, and electricity is presented. Section I includes a summary of energy production and consumption. A brief overview of the state is also included in Section II to provide a background for the energy situation in Alabama. Sections III, IV, and V give a detailed discussion of coal, oil, and natural gas in terms of production activity and consumption patterns from 1972 to 1976. Section VI discusses electricity, an energy form which is derived from the conversion of other fuels, and the agencies which generate electricity and those which supply power to ultimate users are described. Section VII examines each of the end-use sectors - residential, commercial, industrial, agricultural, and transportation - and the relative importance of each to the state as energy consumers. Section VIII summarizes Alabama's energy picture. Although the state is an energy producer, it is necessary to import fuel from other states in order to meet its energy requirements.

BUILDINGS

REFER ALSO TO CITATION(S) 27145, 27249, 27268, 27271, 27442

27302 (BNL—27802) **Simulation model for assessing building energy-conservation policies.** Kleeman, P.T. (Brookhaven National Lab., Upton, NY (USA). National Center for Analysis of Energy Systems). May 1980. Contract AC02-76CH00016. 13p. (CONF-800549—2). NTIS, PC A02/MF A01.

From 11. annual modeling and simulation conference; Pittsburgh, PA, USA (1 May 1980).

A multiple-region simulation model for estimating economic, environmental, and energy-related impacts of building energy-conservation policies is presented. The model is formulated as a time-stepped sequence of optimization subproblems, each reflecting building energy-conservation options and energy costs, and identifying optimal investments and energy consumption for the time step.

27303 (DOE/CS/40163—T1) **Operator manual: high temperature heat pump.** Dyer, D.F.; Maples, G.; Burch, T.E.; Chancellor, P.D. (Auburn Univ., AL (USA). Dept. of Mechanical Engineering). 4 Mar 1980. Contract AC01-79CS40163. 66p. NTIS, PC A04/MF A01.

Experimental data is being obtained from operating a high temperature heat pump system. The use of methanol as a working fluid will necessitate careful monitoring of refrigerant temperatures and pressures with chemical analysis performed on the working fluid during scheduled down time. Materials sent to vendors by Auburn University and quotes received by Auburn concerning equipment (compressor, evaporator, condensor, air heater, dryer, two accumulator tanks, and three expansion valves) are discussed. The simulated dryer and two accumulator tanks were designed by Auburn. The detailed design and pricing estimates are included. Additional information is presented on layout and construction; start-up; testing; shut down; scheduled maintenance and inspection; safety precautions; control system; and trouble shooting.

27304 (LBL—10501) **Implications of international comparisons of energy use: the Swedish/American case reviewed.** Schipper, L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1980. Contract W-7405-ENG-48. 43p. (CONF-800241—1). NTIS, PC A03/MF A01.

From Workshop on contemporary Scandinavian-American issues; Minneapolis, MN, USA (29 Feb 1980).

The comparison of Swedish and US energy use is reviewed. It is seen that more efficient energy use in Sweden accounts for much of the difference in overall energy use observed. Some historical policies are discussed, particularly differences in energy pricing. The record since 1973 is reviewed, and signs of conservation in both countries are found. Some specific areas, such as tight houses, district heating, and lifestyle are reviewed; both countries offer lessons in conservation. Finally, a comparison of some key policy elements is offered.

27305 (ORNL/TM—7319) **Thermal energy storage for building heating and cooling applications. Technical progress report, April 1979-March 1980.** Martin, J.F.; Hoffman, H.W. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 65p. NTIS, PC A04/MF A01.

The ORNL program in Thermal Energy Storage (TES) over the past year is reported. The ORNL effort constitutes one element in the Energy Storage Systems Division of the Department of Energy program to develop TES systems to facilitate conservation and the use of renewable sources. The program consists of developing sensible and latent heat technologies to meet the single goal of reduction in oil and gas consumption for residential and space conditioning. Three specific application elements were addressed: utility load management, solar energy applications, and conservation. Programs (both completed and ongoing) are summarized, and

their relationship to the specific implementation plan are given. Ten final reports of subcontracts were issued over the year. In addition, five final reports are infinal review stage. The program completed a transition from low-temperature storage development including seasonal storage in natural aquifers to TES development for building heating and cooling applications.

27306 State energy audit impact '80 conference. Contract FG01-80CS62118. Norcross, GA; American Inst. of Industrial Engineers (1980). 265p. (CONF-800355—).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

In addition to the 25 papers collected in this proceedings, 12 reprints from recent issues of other publications of AIIE closely related to the theme of the conference are included as references. Also, information about the operation and publications program of AIEE is included. A separate abstract is included for each of the 25 papers.

27307 Regulating energy conservation in existing buildings. Sheridan, R.J. (Massachusetts State Building Code Commission, Boston). pp 6p, Paper 3 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The reasons for making energy conservation in existing buildings a national priority and the arguments favoring a regulatory approach to achieve it are discussed. The institutional setting of the Massachusetts State Building Code Commission is described, and two of its energy-conservation programs affecting existing buildings are treated at length, including the costs of regulation. Certain conclusions are posited concerning essential program considerations which are necessary to assure that such regulation is reasonable and effective. 7 references.

27308 Arkansas building energy audits and energy-efficiency standards. Polk, W.A. (Arkansas Department of Energy, Little Rock). pp 5p, Paper 7 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The activities of Arkansas' energy-conservation program emphasize auditing the energy efficiency of buildings and establishing an efficiency standard for the thermal and lighting systems of new construction. The program emphasizes competent auditing by certified state personnel having experience in the type of building they survey. Recommendations on the basis of the audits stress simplicity and cost effectiveness as a way to increase credibility and public acceptance. Individual responsibility for end-use consumption and its economic impacts is the state's philosophical approach. (DCK)

27309 Assessing energy savings. Capehart, B.L. (Univ. of Florida, Gainesville); Regan, E.J. pp 3p, Paper 18 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

Recent federal and state laws have mandated energy audits for residences, schools, hospitals, and buildings owned by local governments in response to the need for reducing our dependence on fossil fuels. The goal of these laws is to encourage energy conservation by identifying usage-pattern changes, equipment changes, and structural changes which are cost-effective in terms of economic savings. These laws also contain provisions which require some follow-up or verification of the results achieved by the energy-audit process. Even without such legal requirements, good engineering practice would justify these audits. To satisfy the requirements for this audit analysis or audit verification, numerous federal and state agencies and utilities are preparing standardized procedures for collecting audit data and processing it to answer the necessary questions. Substantial progress has been made in this respect, and the purpose of this paper is to describe both the requirements for the audit follow-up and the results achieved by several groups working in this area.

27310 Engineering audits at Minnesota state-owned facilities. Hirst, E. (Oak Ridge National Lab., TN). pp 4p, Paper 19 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

Results obtained from detailed engineering audits performed at 41 institutions operated by the State of Minnesota are analyzed. These institutions include community colleges, state universities, office buildings, hospitals, and Department of Transportation regional facilities. The audits cover 270 buildings and include 2010 individual energy-conservation recommendations. Implementing all these suggestions would cut energy use by 93 MBtu/square foot-audited, equivalent to at least 30 percent of baseline energy use at these institutions. The cost to implement these measures is almost $2/square foot with an average payback period of less than eight years (at 1978 fuel prices).

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 27248, 27266, 27269, 27273, 27371, 27384

27311 (BNL—27519) **Residential gas-fired space-conditioning research and development at Brookhaven National Laboratory.** Woodworth, L.M. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 16p. (CONF-800429—2). NTIS, PC A02/MF A01.

From Institute of Gas Technology conference on future alternatives in residential and commercial space conditioning; Chicago, IL, USA (14 Apr 1980).

Brookhaven National Laboratory has work on-going involving industrial development of gas- and oil-fired space-heating equipment. An analysis of the energy situation indicates that there are significant opportunities to reduce energy waste. These opportunities involve the elimination or reduction of unnecessary consumption and the development of more-efficient equipment. Various options exist for the development of advanced space-conditioning equipment having improved efficiency. The three basic approaches are (1) to increase the capacity of the heat exchanger, (2) to operate with a reduction in excess air, and (3) to reduce standby and cycling losses. The ideal operation of a conventional boiler or furnace is to allow the heat exchanger to operate in the condensing mode at the temperature where the latent heat of vaporization of water vapor in the flue gas is recovered. The resulting efficiency can reach close to 95%. The gas-fired research and development work presently ongoing involve the following: (1) a variable firing rate gas burner, (2) a gas-fired pulse combustion furnace capable of firing 40,000 to 90,000 Btu/hr, (3) a gas-fired pulse combustion boiler with an output of 36,000 Btu/hr, (4) a gas-fired heat pipe furnace firing at 60,000 Btu/hr, and (5) a nonelectric Rankine-cycle gas furnace. A materials program is also underway to identify cost-effective materials for condensing oil- and gas-fired systems, and a study has just been completed that identifies technology for improving the efficiency of heating systems. The method for laboratory and field testing that will assist in commercialization of new, advanced equipment is presented.

27312 (BNL—27873) **Microcomputers for energy conservation in homes and other small buildings.** Hendrick, A.S. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 7p. (CONF-800806—10). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

Low cost microcomputers and related microelectric devices now make it practical to apply additional energy conserving control strategies in single-family homes and other small buildings. These conservation measures can make significant contributions toward attainment of national energy conservation objectives. Applications in space conditioning (heating, cooling, ventilation), lighting, electric demand limiting, metering of energy in various forms and for status displays are outlined. Examples of currently operating installations are described. Available equipment (such as personal computers, A/D converters, sensors, actuators, etc.) is discussed. Efforts at standard interface development and system integration are summarized. Statistics on the numbers of various building types, HVAC system types, energy consumption and energy conservation potential are presented. The structure of the HVAC controls industry is outlined. The US Department of Energy program of research, development and demonstration projects addressing efficient use of energy in buildings with new control systems is described.

27313 (BNL—51159) **Evaluating and selecting options for oil refit programs.** Hoppe, R.; Graves, W.; Salzano, F.J. (Brookhaven National Lab., Upton, NY (USA)). Feb 1980. Contract AC02-76CH00016. 17p. NTIS, PC A02/MF A01.

Brookhaven National Laboratory (BNL) Oil Refit Program provides technical support for the US Department of Energy (DOE) Fuel Oil Conservation Marketing Demonstration Program implemented in several states (designed to accelerate the use of fuel saving devices and systems by homeowners). BNL assisted with the planning and implementation of the marketing and grants option phases for the New York State Pilot Marketing Demonstration Program and is monitoring the results. Additionally BNL planned, and is implementing, the Oil Refit Option Qualification Program involving procedures for evaluating refit options for selection, field testing, and quantifying fuel savings for the purpose of qualifying additional options for use in the DOE state and other marketing programs. The BNL approach for the evaluation of options on a comparative basis is shown and the potential for optimizing fuel savings by combining available single-choice refit options is examined. Also shown are the estimated fuel savings for each option installed.

27314 (CONF-791232—, pp 307-314) **Experimental evaluation of thermal energy storage.** Asbury, J.G.; Hersh, H.N. (Argonne National Lab., IL). 1979.

From Thermal energy storage review meeting; Tysons Corner, VA, USA (3 Dec 1979).

The results of one year of collecting data in Vermont and Maine on the performance of commercially available TES during severe weather conditions, on costs, benefits and customer acceptance of TES, on TES testing standards and further research needs are presented. Findings to date indicate that TES is technically and economically feasible in areas that rely upon electrical space heating. (LCL)

27315 (CONF-800635—3) **Reducing residential energy growth with more efficient space heating equipment.** O'Neal, D.L.; Hirst, E.A. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 18p. NTIS, PC A02/MF A01.

From Conference of the American Society of Heating, Refrigeration and Air Conditioning Engineers; Denver, CO, USA (22 Jun 1980).

Several energy-saving designs changes in residential space heating systems were examined to determine their energy conservation potential and cost effectiveness. Changes in conventional and advanced systems (such as gas heat pumps) were considered. Energy savings as large as 26, 20, and 57% were estimated for design changes in conventional gas, oil, and electric space heating systems, respectively. These changes increased capital cost of the three systems by 27, 16, and 26%. For advanced gas and electric systems, energy savings up to 45 and 67%, respectively, were calculated. The design changes needed to produce these energy savings increased capital costs 80 and 35%. The energy use and cost relationships developed for the space heating systems were used as input to the ORNL residential energy use simulation model to evaluate the effect of space heating improvements on national energy use to the year 2000. With no efficiency improvements in equipment, space heating energy grew at 2.5% per year. When improved conventional and advanced systems were introduced in the market, heating energy growth was cut to 1.8% and 1.6% per year, respectively. In addition, if consumers were to minimize life cycle costs in pruchasing space heating equipment, space heating energy growth was projected to grow at 1.1% per year.

27316 (DOE/CS—0169) **Economic analysis.** (Department of Energy, Washington, DC (USA). Div. of Buildings and Community Systems). Jun 1980. 542p. NTIS, PC A23/MF A01.

The Energy Policy and Conservation Act (EPCA) mandated that minimum energy efficiency standards be established for classes of refrigerators and refrigerator-freezers, freezers, clothes dryers, water heaters, room air conditioners, home heating equipment, kitchen ranges and ovens, central air conditioners, and furnaces. EPCA requires that standards be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. Following the introductory chapter, Chapter Two describes the methodology used in the economic analysis and its relationship to legislative criteria for consumer product efficiency assessment; details how the CPES Value Model systematically compared and evaluated the economic impacts of regulation on the consumer, manufacturer and Nation. Chapter Three briefly displays the results of the analysis and lists the proposed performance standards by product class. Chapter Four describes the reasons for developing a baseline forecast, characterizes the baseline scenario from which regulatory impacts were calculated and summarizes the primary models, data sources and assumptions used in the baseline formulations. Chapter Five summarizes the methodology used to calculate regulatory impacts; describes the impacts of energy performance standards relative to the baseline discussed in Chapter Four. Also discussed are regional standards and other program alternatives to performance standards. Chapter Six describes the procedure for balancing consumer, manufacturer, and national impacts to select standard levels. Details of models and data bases used in the analysis are included in Appendices A through K.

27317 (DOE/CS—0172) **Draft Regulatory Analysis. Technical support document No. 1: energy efficiency standards for consumer products.** (Department of Energy, Washington, DC (USA). Office of Buildings and Community Systems). Jun 1980. 63p. NTIS, PC A04/MF A01.

A Draft Regulatory Analysis is presented that describes the analyses performed by DOE to arrive at proposed energy efficiency standards for refrigerators and refrigerator-freezers, freezers, clothes dryers, water heaters, room air conditioners, kitchen ranges and ovens, central air conditioners (cooling only), and furnaces. Standards for dishwashers, television sets, clothes washers, and humidifiers and dehumidifiders are required to be published in the Federal Register no later than December 1981. Standards for central air conditioners (heat pumps) and home heating equipment are to be published in the Federal Register no later than January 1982. Accordingly, these products are not discussed in this Draft Regulatory Analysis.

27318 (DOE/CS/60521—T1) **Weatherization program: a study of progress.** (Syracuse Research Corp., NY (USA). Energy Research Center). Nov 1979. Contract AC01-79CS60521. 94p. NTIS, PC A05/MF A01.

Progress of the Weatherization Assistance Program (WAP) and other weatherization activities toward national energy conservation goals is reported. Low-income people are among the first to feel the pinch of rising fuel prices, particularly for home heating fuel. WAP installs insulation, storm windows and doors, and other energy efficiency improvements to reduce heat loss in the homes of low-income people, especially with the elderly and the handicapped. The weatherization activities of Federal agencies are described. The study addresses the question of the adequacy and cost of the materials used in weatherization. The series of policy and regulation change questions introduced in the agency-specific section is discussed from a broader perspective. The conclusions are summarized. The appendices present a legislative history of the Program, discuss the operational level of the Program, and describe a cost-benefit analysis of the Program.

27319 (DOE/RG/3356—T1) **Electric and gas utility marketing of residential energy conservation case studies.** (Booz, Allen and Hamilton, Inc., Bethesda, MD (USA)). May 1980. Contract AC01-78RG03356. 105p. NTIS, PC A06/MF A01.

The objective of this research was to obtain information about utility conservation marketing techniques from companies actively engaged in performing residential conservation services. Many utilities currently are offering comprehensive services (audits, listing of contractors and lenders, post-installation inspection, advertising, and performing consumer research). Activities are reported for the following utilities: Niagara Mohawk Power Corporation; Tampa Electric Company; Memphis Light, Gas, and Water Division; Northern States Power-Wisconsin; Public Service Company of Colorado; Arizona Public Service Company; Pacific Gas and Electric Company; Sacramento Municipal Utility District; and Pacific Power and Light Company.

27320 (EMD—80-59) **Slow progress and uncertain energy savings in program to weatherize low-income households.** Staats, E.B. (General Accounting Office, Washington, DC (USA)). 15 May 1980. 61p. General Accounting Office, Washington, DC.

Report to The Congress by the Comptroller General of the United States.

The Department of Energy's Low-Income Weatherization Program could reduce the utility bills of people least able to afford them. However, the program has been hampered by: a lack of procedures for selecting homes, considering both energy savings and the need to reach low-income people; problems in obtaining sufficient labor; a lack of emphasis on rental units; legal limits on administrative expenses at the local level; and inadequate financial management and program monitoring at the Federal, state, and local levels. This report contains several recommendations to the Department of Energy for improving its management of the weatherization program.

27321 (ORNL/CON—42) **Annual cycle energy system (ACES). Performance report, November 1977-September 1978.** Holman, A.S.; Abbatiello, L.A. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 77p. NTIS, PC A05/MF A01.

A single-family residence near Knoxville, Tennessee, is being used to demonstrate the energy-conserving features of the annual cycle energy system (ACES), an integrated heating and cooling system that utilizes a unidirectional heat pump and low-temperature thermal storage. A second house, the control house, is being used to compare the performance of the ACES with that of an electric-resistance heating and hot-water system combined with a central air conditioning system. The results of one year's operation, from November 1977 through mid-September 1978, showed that the ACES consumed 9012 kWhr of electricity and delivered 40.8 x 10^6 Btu (43.03 x 10^9J) of heating, 19.8 x 10^6 Btu (20.89 x 10^9J) of hot water, and 24.8 x 10^6 Btu (26.17 x 10^9J) of cooling; the annual coefficient of performance (COP) was 2.78. The control house consumed 20,523 kWhr of electricity and delivered 41.3 x 10^6 Btu (43.57 x 10^9J) of heating, 14.8 x 10^6 Btu (15.61 x 10^9J) of hot water, and 23.2 x 10^6 Btu (24.41 x 10^9J) of cooling; the annual COP was 1.13. These loads were delivered in a test year in which the heating season was one of the most severe in the past 20 years and the cooling season was normal. In addition, the ACES reduced peak utility system demands significantly: a reduction from 11.7 to 3.1 kW was achieved in the winter and from 4.1 to 0.7 kW in the summer. The only problems encountered were a heat leak into the storage bin that was twice the calculated value and control logic errors that produced excessive hot water in the winter, requiring extensive use of the night heat-rejection mode in the summer. These problems are currently being corrected.

27322 (ORNL/CON—43) **Theory and design of an Annual Cycle Energy System (ACES) for residences.** Nephew, E.A.; Abbatiello, L.A.; Ballou, M.L. (Oak Ridge National Lab., TN (USA)).

May 1980. Contract W-7405-ENG-26. 357p. NTIS, PC A16/MF A01.

The basic concept of the Annual Cycle Energy System (ACES) - an integrated system for supplying space heating, hot water, and air conditioning to a building - and the theory underlying its design and operation are described. Practical procedures for designing an ACES for a single-family residence, together with recommended guidelines for the construction and installation of system components, are presented. Methods are discussed for estimating the life-cycle cost, component sizes, and annual energy consumption of the system for residential applications in different climatic regions of the US.

27323 (ORNL/Sub—7470/1-V1) **Economic evaluation of the Annual Cycle Energy System. Volume I. Executive summary. Final report.** (Honeywell, Inc., Minneapolis, MN (USA). Energy Resources Center). May 1980. Contract W-7405-ENG-48. 70p. NTIS, PC A04/MF A01.

The objective of this study is to determine the energy effectiveness and the economic viability of the ACES concept. Three different classes of building are investigated, namely: single-family residence; multi-family residence; and commercial office building. The application of ACES to each of these building types is studied in three different climatic regions: Minneapolis, Atlanta, and Philadelphia. Computer programs - ACESIM for the residences and CACESS for the office building - were used, each comprised of four modules: loads; design; simulation; and economic. For each building type in each geographic location, the economic evaluation of the ACES is based on a comparison of the present worth of the ACES to the present worth of a number of conventional systems. The results of this analysis indicate that the economic viability of the ACES is very sensitive to the assumed value of the property tax, maintenace cost, and fuel-escalation rates, while it is relatively insensitive to the assumed values of other parameters. Fortunately, any conceivable change in the fuel-escalation rates would tend to increase the viability of the ACES concept. An increase in the assumed value of the maintenance cost or property tax would tend to make the ACES concept less viable; a decrease in either would tend to make the ACES concept more viable. The detailed results of this analysis are given in Section 5.4 of Volume II. 2 figures, 21 tables.

OFFICE BUILDINGS

REFER ALSO TO CITATION(S) 27323

27324 (LBL—10496) **Occupant-generated CO_2 as an indicator of ventilation rate.** Turiel, I.; Rudy, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 24p. (EEB-Vent—80-15). NTIS, PC A02/MF A01.

Ventilation rates in buildings are generally determined by means of tracer-gas techniques that permit calculation of the number of air changes per hour occurring in a given area, or, alternatively, by measuring the actual air flow in the ventilation ducts. There are difficulties associated with both of these methods. In this study in a San Francisco office building, we used occupant-generated CO_2 as an indicator of the actual ventilation rate. Two techniques were employed, a decay method and an integral method and, in both cases, measurements were conducted simultaneously at several locations. The decay method compared favorably with the conventional measurement methods in both the all-outside-air and recirculation modes, whereas the integral method showed a considerable deviation from the other methods in the recirculation mode. Both techniques show promise of being suitable methods for measuring ventilation rate in commercial or institutional buildings.

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

REFER ALSO TO CITATION(S) 27270

27325 (CONF-800548—3) **Interfuel substitution model for institutions of higher education: implications for conservation.** Cohn, S.M.; O'Neal, D.L.; Perry, R.L. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 21p. NTIS, PC A02/MF A01.

From Eastern Economic Association annual meeting; Montreal, Quebec, Canada (8 May 1980).

A model of interfuel substitution is described for colleges and universities in the United States and its implications for conserving fossil fuel resources. There is a significant and growing interest among institutions of higher education in utilizing more efficiently their purchased as well as generated energy sources. An analysis of energy consumption patterns of colleges and universities shows a significant difference in how energy sources are being utilized. Smaller colleges and universities convert purchased fuels directly into end use services such as space heating, water heating, and lighting. The purchased fuels may include electricity and fossil fuels. A more varied fuel use situation exists for larger institutions where not only the above fuel consumption mixture exists, but a central generating plant operated by the university may exist which uses purchased fossil fuels in a primary energy use sense to generate electricity, steam, and chilled water for their own end use requirements. Results indicate that relative changes in fuel prices across a broad cross-section of colleges and universities have significant effects on primary and end-use consumption of fuels. Increasing prices of distillate and residual fuels have a greater energy conservation potential than do equal price increases for coal and natural gas. Electricity is found not to have significant substitution possibilities with the fossil fuels. The results have important overtones for public policy. The structure of the market system may be well suited to handle dislocations in energy price and supplies for colleges and universities; and future decisions by public policy makers may reflect this situation.

27326 (LBL—10223) **Effects of energy-efficient ventilation rates on indoor air quality at an Ohio Elementary School.** Berk, J.V.; Young, R.; Hollowell, C.D.; Turiel, I.; Pepper, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 68p. (EEB-Vent—80-9). NTIS, PC A04/MF A01.

The Lawrence Berkeley Laboratory measured the indoor air quality at Fairmoor Elementary School in Columbus, Ohio. A mobile laboratory was used to monitor air outdoors and at three indoor sites (two classrooms and a large multipurpose room); tests were made at three different ventilation rates. The parameters measured were outside air flow rates, odor perception, microbial burden, particulate mass, total aldehydes, carbon dioxide, carbon monoxide, sulfur dioxide, ozone, and nitrogen oxides. The results of these measurements are given and compared with the existing outdoor air quality standards. Carbon dioxide concentrations increased as the ventilation rate decreased, but still did not exceed current standards. Odor perceptability increased slightly at the lowest ventilation rate. Other pollutants showed very low concentrations, which did not change with reductions in ventilation rate. This study indicates that it would be possible to achieve moderate energy savings at Fairmoor School while maintaining acceptable indoor air quality.

27327 (LBL—10628) **Hospital ventilation standards and energy conservation: a review of governmental and private agency energy conservation initiatives.** Banks, R.S.; Rainer, D. (Minnesota Univ., Minneapolis (USA). School of Public Health). Mar 1980. Contract W-7405-ENG-48. 66p. (EEB-Hosp—79-7). NTIS, PC A04/MF A01.

Results are presented of a study of hospital energy conservation initiatives undertaken at the federal and state levels and by private sector agencies. This study was originally directed toward governmental activities involved with changes to hospital environmental standards. However, it early became apparent that concern with energy conservation was not impacting these standards, especially at the state level, irrespective of the energy implication. Consequently, the study was expanded to include all energy measures directed toward design and operating practices unique to the hospital environment. Information is included on federal standards for hospital construction as contained in the Hill-Burton Act, federal energy conservation legislation, activities at the state level which impact energy conservation in hospitals, and activities of agencies such as Blue Cross-Blue Shield. This study concluded that, while Hill-Burton program standards strongly limit opportunities for energy conservation measures in hospital building space, a number of effective programs - directed toward improved operating practices - have been put in place. These, in themselves, can accomplish substantial energy savings, whether or not hospital environmental standards are changed. (LCL)

27328 Oklahoma Department of Energy's involvement in the development of thermal, lighting, and audit programs. pp 5p, Paper 5 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The Oklahoma State Energy Conservation Plan emphasizing legislation, regulation, and energy audits was started in 1977. Ad hoc committees were set up to develop thermal and lighting standards. Mandatory legislation was passed, but except for some voluntary actions by municipalities, implementation has been slow. An auditing survey of public buildings was developed and applied to identify conservation opportunities. Long-term plans will develop model codes and training programs. (DCK)

27329 Determining the savings realized from monitoring conservation retrofits to schools. Heitz, A.; Rudy, J.; Sigworth, H.W.; Rosenfeld, A.H. (Univ. of California, Berkeley). pp 6p, Paper 20 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The American Association of School Administrators (AASA) estimates that 50% of the energy used by schools is wasted. The Saving Schoolhouse Energy Program was proposed by AASA early in 1976 to provide guidelines for identifying and analyzing energy-

conserving opportunities (ECOs) in existing school buildings and to demonstrate the desirability of retrofitting these buildings. The program emphasized modifications to operational practice and cost-effectiveness of capital modifications utilizing off the shelf hardware. The five-phase program included: (1) site selection and identification of cost-effective ECOs, (2) design modifications needed to accomplish the retrofits, (3) implementation of the retrofits, (4) results monitoring, and (5) dissemination of the findings. Nine schools were monitored by Lawrence Berkeley Laboratory during the 1978-79 heating season. The results of the monitoring pointed out that the schools were not achieving the predicted savings. Without the monitoring program the school administrators, engineers and maintenance staff would have taken significantly longer to determine the effectiveness of the ECOs.

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 27345

27330 Commercial energy audit programs at Alabama Power Company. pp 2p, Paper 10 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

An energy audit program for commercial customers of the Alabama Power Company focuses on individualized audits made at the customer's request. This service is in addition to programs to help local government units and school boards save money by reducing energy use and a self-audit of the utility's 100 buildings, followed by a three-year monitoring of the savings. A thousand written surveys have been provided to commercial utility customers in an effort to help them understand how they can use energy more efficiently. (DCK)

TRANSPORTATION

REFER ALSO TO CITATION(S) 27273, 27442

27331 (DOE/CS/58439—1) **Modal shifts in short-haul passenger travel and the consequent energy impacts.** (United Technologies Corp., East Hartford, CT (USA)). Mar 1980. Contract AC01-76CS58439. 209p. NTIS, PC A10/MF A01.

A study was performed to evaluate the impacts of strategies to effect modal shifts in short-haul passenger travel (defined herein as intercity travel under 500 miles) from energy-intensive modes to those modes that are less energy-intensive. A series of individual strategies, ranging from incentives to the less energy-intensive modes (bus, rail) to penalties to the more energy-intensive modes (auto, air) was examined to determine energy saved and policy implications relative to strategy implementation. The most effective of the individual strategies were then combined in all permutations, and the analysis was repeated. As part of the analytical process, effects of factors other than energy (user cost and time, emissions, government subsidy, and travel fatailities) were examined in a benefit/cost analysis. Finally, energy savings, benefit/cost impacts, implementation considerations, and policy implications were evaluated to arrive at conclusions as to the effectiveness of the more-influential strategies and to the overall effectiveness of induced modal shifts. The principal conclusion of the study is that the maximum 1980 energy saving that might be realized by modal shifts, discounting the concurrent effects of demand suppression and improvement of mode efficiency, is approximately 83 x 10^{12} Btu (46,500 bbl gasoline per day), 3.8% of the total projected 1980 energy consumption in the short-haul transportation sector and 0.23% of the total US petroleum use. It was also concluded that strategies to achieve these small savings by modal shifts would result in significant economic, social, and business disruptions.

27332 (UMTA-IT—09-0068-79-1) **Transportation System Management Prototype Planning Study: Portland. Final report.** Spanovich, G. (Metropolitan Service District, Portland, OR (USA)). Nov 1979. 110p. NTIS.

The results of the Transportation System Management (TSM) Planning Prototype Studies Program are documented. The Program involved five localities: Portland (Oregon), Dallas/Ft. Worth, Kansas City, Seattle and Middlesex County (NJ) and was designed to demonstrate the capabilities of local agencies to undertake TSM planning in a systematic problem oriented manner. This report documents the project in Portland, Oregon and is designed to provide a summary of the procedures utilized in Portland to systematically develop a regionwide program for TSM delineated on a small area basis.

RAILWAY

REFER ALSO TO CITATION(S) 27304

27333 (LBL—10614(2ndDRAFT)) **Locomotive Data Acquisition Package Phase II system development. Final report. Volume 1. System overview.** Abbott, R.K.; Kirsten, F.A.; Mullen, D.R.; Sidman, S.B.; Miller, J.G.; Ng, L.S.; Scalise, D.T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 139p. NTIS, PC A07/MF A01.

An examination of the problems associated with railroad locomotive data acquisition is presented. The design of a minicomputer based locomotive data acquisition system is also presented. Special attention is placed on meeting the functional characteristics and environmental specifications required for the system. The system described consists of a magnetic tape digital data recorder, an ensemble of transducers, and analysis software. The system described is designed as a research tool. The environmental test program and the field test program are also described.

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 27304, 27375, 27378, 27379, 27382, 27384, 27385, 27386, 27391, 27392, 27393, 27394, 27395, 27396, 27397, 27398, 27399, 27408, 27409, 27410, 27411, 27412, 27413, 27414, 27415, 27416, 27417, 27418

27334 (CONF-791082—(Summ.)) **Highway vehicle systems contractors coordination meeting. Seventeenth summary report.** (Department of Energy, Washington, DC (USA). Office of Transportation Programs). 1979. 659p. NTIS, PC A99/MF A01.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Separate abstracts was prepared for each of the 62 papers presented at the Contractors' Coordination meeting on highway vehicle systems. One paper had previously appeared in DOE's data base.

27335 (CONF-791082—(Summ.), pp 6-9) **DOE Heat Engine Program overview for 1980.** Brogan, J.J. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The make-up of the Automotive Technology Development Program, its recent successes, its anticipated near-term accomplishments, and the present status are explained. The Heat Engine Propulsion Systems activities are to develop and demonstrate propulsion systems which are energy efficient and environmentally clean compared with available conventional automotive propulsion systems and to promote commercialization of these new technologies. The Vehicle Systems activities are to provide the needed linkage between the hardware development and the commercialization activities and the Alternative Fuels Utilization activities involve the use of non petroleum-based fuels in highway vehicles ensuring the solutions to these problems are available.

27336 (UMTA-CA—06-0130-80-1) **Santa Monica Mountains recreational transit service. Interim report, June 1979-January 1980.** Webb, P. (Crain and Associates, Menlo Park, CA (USA)). Feb 1980. 146p. NTIS, PC A07/MF A01.

First year operation data of a weekend subscription transit service to a recreational area outside a major metropolitan area are reported. In this demonstration, the Southern California Rapid Transit District, in conjunction with the Santa Monica Mountains Comprehensive Planning Commission, provided low cost, guided trips for groups from heavily transit dependent areas of Los Angeles to two mountain parks in what will soon become a National Recreation Area northwest of the city. The project was intended to measure the demand for such a service and to demonstrate its economic and operational feasibility. This report contains the following elements: an overview of the objectives, innovations, and key evaluation issues for the demonstration; a site description; an accounting of developmental and operational aspects of the service; results of the evaluation; and a description of the potential for future service in both Los Angeles and other settings.

27337 (UMTA-MA—06-0049-80-4) **Evaluation of the EASYRIDE specialized transportation service. Final report, September 1976-May 1979.** Edelstein, P. (Applied Resource Integration Ltd., Boston, MA (USA)). Nov 1979. 352p. NTIS.

The EASYRIDE demonstration project took place in New York City's Lower East Side of Manhattan. The Vera Institute of Justice was the grantee for the project in which door-thru-door demand-responsive transportation service was provided to elderly and handicapped residents of the Lower East Side. Service was provided by five fully accessible lift-equipped vans and five regular vans. Most drivers for the EASYRIDE project were graduates of the Wildcat Corporation program which trains rehabilitated ex-offenders and ex-addicts for work on public service projects. The evaluation report covers the first two full years of operation, from June 1977 through May 1979. EASYRIDE has been granted an additional two year demonstration extension and, as a result, the project is still in operation. Results of the evaluation indicate that

EASYRIDE provides about 3000 one-way trips per month at an average hourly cost of $27.34. The average cost per trip is about $12.87.

PIPELINE

REFER ALSO TO CITATION(S) 27380, 27381, 27383, 27387, 27428

27338 (CONF-791082—(Summ.), pp 359-373) **Controlled Speed Accessory Drive (CSAD) demonstration project.** Courville, G.M. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

A controlled speed accessory drive system has the potential for a fuel economy improvement of 5 to 10% over conventional fixed-ratio drives. A testing plan at JPL calls for a program involving three phases: familiarization, pilot test, and fleet test. In support of Phases II and III, DOE and GSA are conducting a test on 250 CSAD systems on late model (1977 and 1978) Ford Pintos at Boston, Kennedy Space Center, Dallas/Fort Worth, and Denver. Phase III will involve 400 GSA vehicles at various motor pool locations nationwide. The major objective of Phase III is to determine the level of fuel economy improvement with the CSAD system over a one year period. Specific results of the Phase II activities are reported.

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 27272

27339 (ANL/CNSV-TM—37) **Industrial cogeneration case study No. 2: American Cyanamid Chemical Company, Bound Brook, New Jersey.** (Faucett (Jack) Associates, Inc., Chevy Chase, MD (USA)). Jan 1980. Contract W-31-109-ENG-38. 41p. NTIS, PC A03/MF A01.

Within a project for evaluating the economics of cogeneration for industrial plants with an electrical capacity of 10,000 to 30,000 kW, the American Cyanamid plant at Bound Brook, NJ was selected for study. Built between 1915 and 1920 this power plant was converted in the 1960's from coal-fueling to oil and natural gas. Information is presented on the plant site, fuel usage, generation costs, comparative cost of purchasable electric power, equipment used, performance, and reliability and capital and maintenance costs. (LCL)

27340 (BNL—27862) **Industry process models: applications for market penetration and energy use projections.** Pilati, D.A.; Howe, S.O.; Balzer, C.; Sparrow, F.T. (Brookhaven National Lab., Upton, NY (USA); Purdue Univ., Lafayette, IN (USA)). May 1980. Contract AC02-76CH00016. 22p. (CONF-800565—2). NTIS, PC A02/MF A01.

From TIMS/ORSA national meeting; Washington, DC, USA (4 May 1980).

The Brookhaven National Laboratory pulp and paper industry process model is used to project market penetration of energy conserving technologies and purchased energy for the paper industry. The risk adjusted discount rate concept is incorporated to penalize the capital costs of unproven technologies. For this analysis, the production-cost minimization objective is relaxed to explore near-minimum cost industry alternatives. Allowing paper production to include all possibilities within 1% of the absolute minimum costs results in very significant variations in both projected market penetration levels and energy use. Industry model results relying solely on the cost minimization objective for market penetration and energy demand forecasts may be highly suspect.

27341 (COO—2862-T1) **Energy analysis of 108 industrial processes. Phase 1, industrial applications study.** Hamel, B.B.; Brown, H.L. (Drexel Univ., Philadelphia, PA (USA)). Jun 1979. Contract EY-76-S-02-2862. 432p. NTIS, PC A19/MF A01.

Extensive data are compiled for energy balances in 108 industrial processes. Specific information on unit operation, material, temperature, unrecoverable losses, along with the process flow diagram is given for each of the industries. The following industries are included: meak packing; milk; canned fruits and vegetables; baked goods; sugar refining; soybean; textiles; wood products; building materials; alkalies and chlorine; inorganic gases; pigments, chemicals; plastic materials and resins; synthetic rubbers; organic fibers; pharmaceutical preparations; organic chemicals; petroleum products; fertilizers; rubber products; glass; blast furnaces and steel mills; metals; farm machinery; motor vehicles; and photographic materials. The SIC's for each industry are identified.

27342 **Texas' response to small industry.** Baldwin, P. (Texas Energy and Natural Resources Advisory Council, Austin). pp 3p, Paper 1 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

Texas began an on-site assistance program in 1979, aimed at helping small industry. This program advocates a one-on-one approach between professional engineers and industrial operators. In the 9 months it has been in full operation, a total of 141 clients located in 23 cities have participated in the program. A potential energy savings of 485 x 10^9 Btu's has been identified through this program. It is felt that the program complements the successful workshop program aimed at getting energy management information out to the end user. The on-site technical assistance program has received such support that it will be expanded in 1980 from four engineers to 6 and one half-time personnel. Three case histories from the program are reported.

27343 **Oklahoma industrial energy management program.** Estes, C.B.; Turner, W.C. (Oklahoma State Univ., Stillwater). pp 7p, Paper 4 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The Oklahoma Department of Energy designed a program to acquaint small and medium companies with the potential savings available through energy management and some of the basic techniques for developing an energy management program. The offerings, impact to date, and future plans of the Oklahoma Industrial Energy Management Program are described. Past successes will ensure its continuation, although the program will be reviewed and modified as needed. 29 references.

27344 **Energy conservation today: GM's program.** Kelly, R.L. (General Motors Corp., Detroit). pp 9p, Paper 12 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

General Motors Corporation (GM) has devoted large amounts of capital and manpower to improve energy efficiency. They feel that a successful energy-conservation program must have total involvement at all levels of management, centering around energy accountability. Total involvement includes top management support, effective communication, motivation, and enthusiasm. Designers, engineers, and production personnel must work together to achieve difficult but attainable goals. Energy accountability is knowing how much energy you use, how much it costs, where it is being used, and who is using it wisely. Utilization of these techniques will achieve higher energy efficiency.

27345 **Energy management at Western Electric.** Heggie, D.A. (Western Electric Co., New York). pp 7p, Paper 13 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

This overview of the energy management program within a large multi-plant Company provides insight into why energy management and energy conservation is good business. It outlines the structure of an energy-management program and gives examples of accomplishments achieved through effective energy management, which emphasizes efficient energy use. 7 figures.

27346 **Cost reduction through energy conservation.** Doerr, R.E. (Monsanto Co., St. Louis, MO). pp 3p, Paper 14 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The Monsanto Company's conservation program reduced energy consumption 22.5 percent from 1972 levels, considerably better than the 14 percent goal which DOE set for the chemical industry. Energy costs during the same period increased five times. Monsanto predicts this will increase to 10 times by 1985 and has set a goal of 35 percent reduction below 1972 levels to save money. Monsanto recognizes the value of energy conservation as a cost-reduction technique and performs an energy review for all new capital projects. Three management methods are used to monitor performance: (1) the percent reduction in energy rate is used for capital projects; (2) the activity method and (3) the Chemical Manufacturers Association Energy Rate Method are used for existing facilities. Examples of conservation achievements at individual plants are noted. (DCK)

27347 **Energy conservation in United Kingdom.** Bradley, C.C. (Department of Industry, London, England). pp 5p, Paper 23 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The United Kingdom's present policy towards energy conservation in industry is discussed. Estimates for potential savings in different sections of industry show that for overall industry, at least 20% is possible. Government measures to promote conservation include (in descending order of priority) correct pricing, information, regulations, research and development, and direct incentives. Although it is too early to judge the effectiveness of these measures or industry's response, there are encouraging signs in the ratio of energy consumption to productivity.

ENERGY SOURCES

REFER ALSO TO CITATION(S) 27304

27348 (ANL/EES-TM—80) **Overview of Department of Energy initiatives concerning industrial boiler new source performance standards.** Connolly, M.J.; Surles,T. (Argonne National Lab., IL (USA)). Dec 1979. Contract W-31-109-ENG-38. 48p. NTIS, PC A03/MF A01.

To combat a pending long-term crisis, the development of our domestic resources became a priority, and the National Energy Plan (NEP) defined goals of increased coal production to be implemented in the 1980s. The use of coal in industrial boilers represents one avenue through which the NEP goals can be attained. However, the potential levels of the Industrial Boiler New Source Performance Standards (IBNSPS) to be promulgated by the United States Environmental Protection Agency (EPA) could have an adverse impact onthe NEP goals by increasing the cost of coal utilization and thereby decreasing demand. This possible adverse impact on coal utilization provides the focus of the IBNSPS study. The Department of Energy (DOE) has been officially requested to respond to the IBNSPS that will be proposed by the EPA in September 1980. The IBNSPS are more complex than the existing Utility Boiler New Source Performance Standards (UBNSPS), because of the large number of potential industrial sources and their lack of uniformity. The purpose of this report is to review the rationale for the NSPS program and to highlight the Department of Energy (DOE) methodology for determining the potential results of the program. The Industrial Fuel Choice Analysis Model (IFCAM), which will be used to assess the impacts of the potential levels of the IBNSPS, is discussed in depth. The DOE's Technology Assessment Reports are reviewed, along with the status of the IBNSPS study and alternative study approaches that may be pursued to enhance DOE's participation in the rule-making process. Furthermore, the alternative study approaches may provide DOE with a viable plan in the event that the IFCAM problems are not resolved.

27349 (ORNL/TM—7165) **Effects of alternate fuels report No. 8: analysis of degradiation of magnesia-based refractory bricks from a residual oil-fired rotary cement kiln.** Federer, J.I.; Tennery, V.J. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 29p. NTIS, PC A03/MF A01.

Residual oil was used as an alternate fuel to natural gas to supply heat in a rotary cement kiln. Principal impurities in the residual oil were Ca, Fe, Mg, Na, Ni, P,S. and V. the kiln operators were concerned about the effects of these oil impurities on observed degradation of the magnesia-based bricks used as a liner in the burning zone of the kiln. Two degraded bricks, which had been in service for six to nine months, were analyzed to determine the role of fuel impurities on the observed degradation. The maximum hot-face temperature of the refractory during service was about 1500°C. One brick had decreased in thickness about 45%, the about 15%. Various analytical measurements on these samples failed to reveal the presence of fuel impurities at or near the hot face of the bricks, and therefore it is concluded that the relatively short service life of these refractories was not due to use of residual oil as the fuel in the kiln. The observed degradation, therefore, was attributed to other reactions and to thermal mechanical conditions in the kiln, which inevitably resulted in extensive erosion of the bricks.

27350 (ORNL/TM—7267) **Effects of alternate fuels refractory test facility test 3, Part 1. Analysis of alumina and aluminosilicate fibrous insulations exposed to the combustion products of No. 6 residual oil.** Federer, J.I.; Tennery, V.J. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 52p. NTIS, PC A04/MF A01.

Residual oil is being used as an alternate fuel to natural gas and distillate oil in many industrial process heat applications. A consequence of this action is more rapid deterioration of refractories and refractory insulations due to impurities in the oil that are not present in gas and distillates. In this test alumina-based fibrous insulations were exposed to the combustion products of No. 6 residual oil to identify specific fuel impurity reactions and to compare the results with those in other tests using oils containing different impurity levels. The four specimens in this test contained 46 to 98% Al_2O_3 equivalent; the balance was mostly SiO_2. These were installed on the wall of a test furnace and exposed to the combustion products for 1002 h at a hot-face temperature of 1350°C. The major impurities in the oil - Fe, Mg, Na, Ni, P, Si, Ti, and V - and two minor impurities, Ba and Ca, were mostly concentrated in a thin reaction layer on the hot face. Some impurities, including sulfur, penetrated the reaction layer into the fibers. The reaction layer on each specimen contained crystalline phases, but only the specimen of highest Al_2O_3 content had new crystalline phases containing fuel impurities. The reaction layer on the other specimens contained original crystalline phases plus glass. Glass probably formed as a result of reaction between SiO_2 and Na_2O derived from the fuel, and the amount of glass increased with increasing SiO_2 content. None of the insulations were seriously degraded during the test exposure. The temperature difference between the hot and cold faces remained approximately constant during the exposure, indicating no substantial change in the effective thermal conductivity.

MATERIALS

27351 (DOE/CS/40032—T1) **Performance evaluation of in-service, elevated temperature industrial insulation.** Martin, D.J. (York Research Corp., Stamford, CT (USA)). 18 Dec 1978. Contract EC-77-C-02-4095. 76p. NTIS, PC A05/MF A01.

A purchaser of industrial insulation is concerned with many factors which bear on the type of insulation selected. One of the most important factors, undoubtedly, is the thermal conductivity. The thermal conductivity is a measure of the ability of an insulation to conduct heat. The lower this value the better the insulation appears to the buyer. In the past it was generally assumed that the conductivity during the life of the insulation could be taken as a fixed property so long as external influences such as moisture or physical damage do not occur. Due to the dramatic increase in the cost and availability of energy in recent years, investigation of the validity of this long-standing assumption is in order. The purpose of this study was to determine whether deterioration of industrial insulation does occur and, if so, attempt to identify the reasons. In order to accomplish this, it was necessary to first develop methods by which the conductivity could be determined in the field. Once this was accomplished, a field test program was implemented. It was determined from this program that there was a significant difference between the conductivity values obtained and those which were expected from manufacturer's data. However, this variation was not attributable to any of the factors investigated and could be due to either inherent measurement inaccuracies or the tendency of manufacturers' data to overestimate performance.

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 27256

27352 (CONS—4203-T1) **Pulverized coal firing of aluminum melting furnaces. First annual technical progress report, May 1978-June 1979.** West, C.E.; Hines, J.E.; Stewart, D.L. Jr.; Yu, H. (Aluminum Co. of America, Alcoa Center, PA. Alcoa Labs.). Oct 1979. Contract EM-78-C-01-4203. 40p. NTIS, PC A03/MF A01.

The ultimate objective of this program is the commercial demonstration of an efficient, environmentally acceptable coal firing process suitable for implementation on melting furnaces throughout the aluminum industry. To achieve this goal, the program has been divided into two phases. Phase I has begun with the design and construction of a 350 lb/h (coal) staged slagging cyclone combustor (SSCC) attached to a 7-ft dia aluminum melting ladle furnace. Process development will culminate with a 1000 pph prototype SSCC firing a 40,000 lb capacity open hearth melting furnace at the Alcoa Laboratories. Phase II implementation is currently planned for Alcoa's Lafayette, IN, Works, where two of the ingot plant's five open hearth melting furnaces will be converted to utilize coal. In addition to confirmation of data gathered in Phase I, the effect of extended production schedule operation on equipment and efficiencies will be determined. This work would begin in 1982 pursuant to technical and economic evaluation of the process development at that time. A major design subcontract for assistance in the design of the SSCC is 80% completed.

27353 (COO—4649-10) **Energy conservation via heat transfer enhancement. Quarterly progress report, 1 July-30 September 1979.** Junkhan, G.H.; Bergles, A.E.; Webb, R.L. (Pennsylvania State Univ., University Park (USA); Iowa State Univ. of Science and Technology, Ames (USA). Engineering Research Inst.). Nov 1979. Contract ET-78-S-02-4649. 29p. NTIS, PC A03/MF A01.

This report for the third quarter of 1979 summarizes contacts relative to the theory and practice of heat transfer enhancement. The Technical Literature File and the Manufacturers' File continue to be updated. The Patent File is being utilized as source material for a future report on patent technology; this file is continuously updated from the Patent Gazette. Technology studies on porous boiling surfaces and enhancement of flow boiling in helically-coiled tubes

are discussed. An application study on evaluation of enhanced surfaces for OTEC applications has been initiated.

27354 (DOE/CS/40060—1) **Energy conservation in grain (corn) drying with combiation high-temperature, low-temperature methods. Final report, July 1, 1978-December 31, 1979.** Morey, R.V.; Gustafson, R.J.; Cloud, H.A.; Walter, K.L. (Minnesota Univ., Rosemount (USA). Rosemount Agricultural Experiment Station; Minnesota Univ., St. Paul (USA). Dept. of Agricultural Engineering). 1 Mar 1980. Contract AS02-78CS40060. 36p. NTIS, PC A03/MF A01.

The need to conserve energy has led to efforts to improve efficiency of grain drying systems. Combination high-temperature, low-temperature drying offers potential for meeting this need. Combination drying is any system in which high-temperature drying is followed by in-storage cooling and low-temperature drying. The high-temperature (120 to 240°F) phase can be a continuous flow or automatic batch dryer, or a bin dryer using elevated air temperatures (continuous flow; unstirred, stirred or recirculated batch. The purpose of the high-temperature dryer is to reduce the corn moisture content to a level where drying can be safely completed with in-storage, low-temperature methods. In-storage drying is accomplished by moving low-temperature air through the grain mass. This process may take from four to eight weeks, or longer, to complete. In fact, drying may be halted in late fall and completed during the following spring. Potential advantages of the combination approach compared to conventional drying with in-drying cooling include: reduced energy requirements, increased drying capacity, and improved grain quality. Combination drying studies from four corn harvest seasons (1975 to 1978) at the University of Minnesota Rosemount Experiment Station, and results of simulation analysis of the low-tempeature phase of combination drying are presented. The model used for this analysis was validated with experimental data from the field studies. Finally, design and management recommendations, and economic considerations for combination drying are discussed. (LCL)

27355 (DOE/CS/40098—T1) **Energy conservation research in the paper and allied products industry. Phase 1.** Clark, J.L.; Holcombe, W.D.; Hartley, E.M.; Carr, W.W. (Georgia Inst. of Tech., Atlanta (USA). Engineering Experiment Station). Oct 1979. Contract AS05-78CS40098. 135p. NTIS, PC A07/MF A01.

The Engineering Experiment Station of the Georgia Institute of Technology has conducted a study of certain concepts for energy conservation in the paper manufacturing industry. The primary emphasis of the study was evaluation of a textile industry device called a Machnozzle as an aid to dewatering of the press section felts. Experimental results indicate that significant reduction in felt moisture may be obtained by installing and operating the Machnozzle just prior to the suction box. Analysis of the economic and energy impact is hampered by lack of a clear understanding of the relationship between felt moisture and paper sheet moisture. Further study in this area is recommended. Also addressed in this project is the concept of maintaining higher feedstock temperatures, particularly through retention of thermal energy from the pulping process. Various problems relating to high temperature processing are discussed.

27356 (DOE/CS/40163—T2) **Design manual.** Burch, T.E.; Chancellor, P.D.; Dyer, D.F.; Maples, G. (Auburn Univ., AL (USA). Dept. of Mechanical Engineering). Jan 1980. Contract AC01-79CS40163. 142p. NTIS, PC A07/MF A01.

The design and performance of a waste heat recovery system which utilizes a high temperature heat pump and which is intended for use in those industries incorporating indirect drying processes are described. It is estimated that use of this heat recovery system in the paper, pulp, and textile industries in the US could save 3.9 x 10^{14} Btu/yr. Information is included on over all and component design for the heat pump system, comparison of prime movers for powering the compressor, control equipment, and system economics. (LCL)

27357 **Minimizing fossil fuel energy in corn drying systems.** Keener, H.M; Glenn, T.L.; Misra, R.N. (Ohio Agric Res and Dev Cent, Wooster). *ASAE Tech. Pap.;* 27(1979). (CONF-7906167—).

From ASAE and CSAE Canadian Society of Agricultural Engineering summer meeting; Winnipeg, Canada (24 Jun 1979).

This paper analyzes grain drying systems for their least fossil fuel energy use. Two approaches, selecting the fuel source and controlling the drying process, are considered in an effort to achieve fossil energy conservation. Techniques of analysis are presented along with energy conversion coefficients for energy sources. Optimum dryer designs for maximizing savings in fossil fuel are given along with actual fuel cost for the dryer operation. Refs.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 27369

27358 (ANL/CNSV-TM—34) **Application of fluidized-bed technology to the recovery of waste heat.** Vogel, G.J.; Grogan, P.J.; Evans, A.R. (Argonne National Lab., IL (USA)). Aug 1979. Contract W-31-109-ENG-38. 73p. NTIS, PC A04/MF A01.

The fluidized-bed, waste-heat boiler (FBWHB) may represent a significant opportunity for industrial energy conservation. The applications of FBWHBs to the recovery of heat from waste streams are examined. Compared to other waste-heat recovery units, FBWHBs can transfer more heat per unit volume and are physically smaller - an important consideration for retrofit and construction costs. A detailed discussion of fluidized beds, including their application in waste-heat recovery and the factors affecting FBWHB design is presented. Design methodology is discussed along with a preliminary engineering design for recovering heat from a waste-gas stream, a typical FBWHB application.

27359 (LA-UR—80-1481) **High temperature heat pipes for waste heat recovery.** Merrigan, M.A.; Keddy, E.S. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 8p. (CONF-800712—2). NTIS, PC A02/MF A01.

From 15. AIAA thermophysics conference; Snowmass, CO, USA (14 Jul 1980).

Operation of heat pipes in air at temperatures above 1200°K has been accomplished using SiC as a shell material and a chemical vapor deposit (CVD) tungsten inner liner for protection of the ceramic from the sodium working fluid. The CVD tungsten has been used as a distribution wick for the gravity assisted heat pipe through the development of a columnar tungsten surface structure, achieved by control of the metal vapor deposition rate. Wick performance has been demonstrated in tests at approximately 2 kW throughput with a 19-mm-i.d. SiC heat pipe. Operation of ceramic heat pipes in repeated start cycle tests has demonstrated their ability to withstand temperature rise rates of greater than 1.2 K/s.

27360 (ORNL/TM—7166) **Corrosion of a stainless steel waste heat recuperator.** Federer, J.I.; Tennery, V.J. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 41p. NTIS, PC A03/MF A01.

Waste heat recuperation has significant potential for saving energy in fossil-fuel-fired industrial furnaces. Preheating the air used to burn the fuel can significantly reduce fuel consumption. The US Department of Energy is contracting several high-temperature waste heat recuperation demonstrations with the objective of using successful efforts to stimulate the industrial utilization of these devices. One of the recuperator demonstration contracts has as an objective the successful operation of a concentric-shell radiation recuperator of a new design on aluminum-scrap-remelting furnaces. The design employs type 309 stainless steel reradiant inserts within the type 309 stainless steel inner shell to increase heat radiation to the recuperator partition, thereby increasing the heat exhanger's effectiveness. The first demonstration recuperator in this program was installed on a furnace fired with No. 2 oil and melting about 60 Mg (66 tons) of aluminum per 24-h day. The unit operated for about 30 d and provided air to the burner at 540°C. during this period, a burner control misoperation provided very fuel-rich gases to the base of the recuperator. This fuel combined with safety dilution air at the recuperator base and burned within the recuperator. Also, during this period, air flow loss was detected at the burner. An inspection revealed that this was caused by failure of the partition wall separating the primary and secondary sides of the recuperator. Extensive corrosion of the partition wall and reradiant inserts was also observed. The recuperator was removed from the furnace for an analysis of the failure.

27361 (ORO—5623-T2) **US Department of Energy waste heat utilization project for the Paducah, Kentucky Uranium Enrichment Gaseous Diffusion Plant. Final report, 29 September 1978, Volume I.** (Sirrine (J.E.) Co., Raleigh, NC (USA); Research Triangle Inst., Research Triangle Park, NC (USA); AiResearch Mfg. Co., Torrance, CA (USA)). 1978. Contract EC-77-C-05-5623. 388p. NTIS, PC A17/MF A01.

Concepts which would make optimum use of the process heat currently being wasted at the Paducah Gaseous Diffusion Plant (GDP) were studied. The results show that a waste heat complex could be developed which would take the 150°F GDP cooling water and through enhancement techniques produce 300 to 350°F thermal energy for industrial processes at an amortized system cost of $1.95/10^6 BTU. An optimum complex of industrial users of this enhanced waste heat would consist of a power plant, an alkali/chlorine plant, a pulp/paper plant, a soybean oil mill, and a wet corn milling plant, all operating in a co-generation configuration. Such a complex would result in the effective use of 8.6% of the Gaseous Diffusion Plant waste heat, or a saving of 1.25 x 10^6 barrels/year oil equivalent. This report defines the GDP/waste heat complex interface characteristics, presents parametrics for the waste heat utilization methods of power generation and heat pumping, evaluates the energy use characteristics of many candidate industrial processes, and matches the enhancement methods with industrial end-users. Preliminary energy costs and candidate end-users were developed in

order to reduce the scope of waste heat alternatives. Social, political, and economic factors germane to the Paducah area were evaluated. The preliminary results were refined to give detailed characteristics of the enhancement equipment waste heat marketing, production and use, and an evaluation of the socio/political/economic factors associated with the development of the proposed waste heat complex. The technical and economic viability of such a waste heat complex and shows that an enhanced temperature industrial complex with its attendant savings of 1.25 x 10^6 barrels/year oil equivalent could be established adjacent to the Paducah GDP facility with a very positive impact upon the quality of life for the citizens of this area.

27362 Waste heat recovery--heat exchanger fouling and corrosion. Silvestrini, R. (AiRes Manuf Co of Calif, Torrance). *Chem. Eng. Prog.;* 75: No. 12, 29-35(Dec 1979).

This paper is concerned with waste heat recovery from large stationary diesel engines and related problems of tube fouling and corrosion. It is demonstrated by experimental data that operating a heat exchanger below the acid dewpoint in the exhaust stream of a diesel engine burning a No. 6 residual fuel did not reproduce the corrosion rates reported in the literature under gas-fired boiler conditions. It is theorized that two fouling mechanisms are active in the 66 to 288$degree$C temperature range: acid condensation and hydrocarbon condensation. Fin type does not affect fouling rate. Plain and serrated fin modules with identical fin densities and heights had the same fouling thickness increases in the same period of time. Fins of greater density fouled worse in terms of flow area reduction than did more widely spaced fins. This beneficial effect of fouling on inhibiting corrosion must be viewed with caution until the effects of fouling and cleaning on heat exchanger performance are evaluated. 3 refs.

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 27368, 27370

27363 (BM-RI—8436) **Synergism in polyethylene oxide dewatering of phosphatic clay waste.** Smelley, A.G.; Scheiner, B.J. (Bureau of Mines, Tuscaloosa, AL (USA)). 1980. 21p. Bureau of Mines, Washington, DC.

As part of research conducted in its mission to effect pollution abatement, the Bureau of Mines, US Department of the Interior, is developing a dewatering technique that allows for disposal of phosphatic clay wastes, for reuse of water now lost with clays, and for reclamation of mined land. The technique utilizes a high-molecular-weight nonionic polyethylene oxide polymer (PEO) that has the ability to flocculate and dewater phosphatic clay wastes. A synergistic flocculation study was made to determine whether a portion of PEO could be replaced by other reagents. Several groups of reagents were tested: (1) those that increased the zeta potential of the phosphatic clay wastes; (2) those capable of hydrogen bonding; and (3) those which flocculated the phosphatic clay waste. Reduction in PEO consumption occurred only with addition of those reagents able to flocculate the slime. The use of natural guar gums resulted in a lower PEO requirement and also yielded a dewatered product of higher solids content, 43 to 45%, versus 33 to 35% obtained with PEO alone.

27364 (NP—24435) **Cogeneration possibilities for grain drying: a look at using waste heat to dry small grains in the state of Kansas.** Hochstetler, T. (Kansas Energy Office, Topeka (USA)). 3 Mar 1980. 6p. NTIS, PC A02/MF A01.

Many internal combustion engine power plants and industrial boilers have sufficient quality waste heat which could be used in the agricultural sector for drying small grains. These waste heat opportunities are often located near grain storage or processing units, and afford enough heat to handle local grain drying requirements. This method of grain drying may be one of the more simple and practical applications of cogeneration in rural areas.

27365 (UCID—18706) **Safety Analysis (SA) of the Hazardous Waste Disposal Facilities (Buildings 514, 612, and 614) at the Lawrence Livermore Laboratory.** Odell, B.N.; Toy, A.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Dec 1979. Contract W-7405-ENG-48. 64p. NTIS, PC A04/MF A01.

This safety analysis was performed for the Manager of Plant Operations at LLL and fulfills the requirements of DOE Order 5481.1. The analysis was based on field inspections, document review, computer calculations, and extensive input from Waste Management personnel. It was concluded that the quantities of materials handled do not pose undue risks on- or off-site, even in postulated severe accidents. Risks from the various hazards at these facilities vary from low to moderate as specified in DOE Order 5481.1. Recommendations are made for additional management and technical support of waste disposal operations.

MUNICIPALITIES AND COMMUNITY SYSTEMS

27366 (ANL/CNSV-TM—38) **Energy-conserving development regulations: current practice.** (American Planning Association, Chicago, IL). May 1980. Contract W-31-109-ENG-38. 138p. NTIS, PC A07/MF A01.

Almost every aspect of land development has an effect on energy use, from minute architectural details to broad considerations of urban density. Energy-efficiency depends in part on how development is planned and carried out. Conventional development regulations, such as zoning ordinances and subdivision regulations, can be adapted in many ways to promote energy conservation at the community level. This report is about energy-efficient site and neighborhood design. It examines recent experiences of local governments that have adopted new development regulations or amended existing ones to promote energy conservation, more efficient generation and distribution, or a switch to alternative, renewable sources. Although much has been written in recent years about saving energy through community design, actual experience in applying these new ideas is still limited. To date, most communities have focused their efforts on studying the problem, documenting consumption patterns, and writing reports and plans. Only a handful have amended their land-use controls for the express purpose of saving energy. This study identifies 13 of these pioneering communities, after undertaking a survey of over 1400 local, regional, and state planning agencies. It takes a look at their experiences, to learn what has been done, how well it has worked, and what problems have been encountered.

CONSERVATION SERVICES

REFER ALSO TO CITATION(S) 27269

MUNICIPAL WASTE MANAGEMENT

27367 (BM-RI—8429) **Pilot-scale studies on the composition and characteristics of urban refuse.** DeCesare, R.S.; Palumbo, F.J.; Sullivan, P.M. (Bureau of Mines, Avondale, MD (USA). Avondale Research Center). 1980. 36p. Bureau of Mines, Washington, DC.

Operation of the Bureau of Mines raw refuse continuous separation pilot plant is described, including modifications made to plant equipment for improved performance. Products recovered from refuse, many of which have been evaluated by other laboratories and private firms, are discussed. Sampling procedures used in the pilot plant and detailed data obtained from processing refuse from 13 municipalities are presented in appendixes. Fuel evaluations made on combustible fractions of refuse from the various municipalities are also presented. Information and data obtained at the pilot plant have been used to assist many municipalities in solving their urban refuse problems.

27368 (EPA-SW—536) **Resource conservation and recovery: current reports.** (Environmental Protection Agency, Washington, DC (USA)). Mar 1980. 35p. Environmental Protection Agency, Cincinnati, OH.

A 32 page bibliography of references of resource recovery, recycling, waste processing, and materials recovery is presented. The references are divided into categories of general information, the Resource Conservation and Recovery Act, resource conservation in packaging and in recycling containers, industrial wastes, energy recovery, and the technology and markets for recovered materials. Any item listed can be ordered from the US EPA. (LCL)

27369 (NP—24433) **Inventory of Kansas waste energy resources: a preliminary survey of waste energy resources in Kansas that could be used as sources of process energy for alcohol production.** Noon, R.; Hochstetler, T. (Kansas Energy Office, Topeka (USA)). Apr 1980. 15p. NTIS, PC A02/MF A01.

Estimates indicate that Kansas could produce up to 200 to 300 million gallons of anhydrous, ethanol per year, but it would require a significant amount of process energy to operate the ethanol production plants. Kansas has a number of untapped waste energy resources that could provide the required process energy for ethanol production instead of using conventional fuels. These include cogeneration, the direct combustion of municipal wastes, and the conversion of animal wastes into methane. The potential of these resources is examined.

27370 (SAN—1609-T1) **Maximizing the life cycle of plastics. Final report.** Hawkins, W.L. (Plastics Inst. of America, Inc., Hoboken, NJ). Feb 1980. Contract EC-77-S-03-1609. 800p. NTIS, PC A99/MF A01.

The Plastics Research Institute has conducted a coordinated research program designed to extend the useful life of plastics. Since feedstock for practically all synthetic plastics is derived from fossil fuel, every effort should be made to obtain the maximum useful life from these materials. Eventually, plastic scrap may be used as a fuel supplement, but this disposal route should be followed only after the

scrap is no longer reusable in its polymeric form. The extent to which plastic scrap will be recovered and reused will be affected by the economic situation as well as the available supply of fossil fuel. The Institute's program was conducted at five major universities. Dedicated faculty members were assembled into a research team and met frequently with members of the Institute's Board of Trustees to review progress of the program. The research was conducted by graduate students in partial fulfillment of degree requirements. Summaries are presented of the following research projects: Improved Stabilization; Separation of Mixed Plastic Scrap; Compatibilizing Agents for Mixed Plastic Scrap; Controlled Degradation of Plastic Scrap; and Determination of Compatibility.

EDUCATION AND PUBLIC RELATIONS

REFER ALSO TO CITATION(S) 27289, 27308, 27343

27371 (DOE/CS—0139) **Saving money with energy conservation: an energy audit workbook for apartment buildings.** (Department of Energy, Washington, DC (USA). Office of Conservation and Solar Applications). Jul 1980. 35p. NTIS, PC A03/MF A01.

Part 1 of this booklet lists 14 ideas with high potential for savings. Part 2 is a list of ideas intended for the apartment renter. Part 3 contains more ideas for management which require little or no initial investment and offer significant savings. Part 4 has even more ways to save but with some investment. Following these idea sections, Part 5 contains four forms to help manage an energy conservation program. Part 5 also has two examples to show how the dollar savings potential of the various ideas can be estimated. This workbook provides a do-it-yourself, fill-in-the blanks approach to an energy conservation program for apartments.

27372 **DOE auditor-training curriculum.** Kennedy, W.J. Jr. (Univ. of Utah, Salt Lake City); Gochenour, D.L. pp 3p, Paper 15 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The American Institute of Industrial Engineers, under contract to the Department of Energy, developed, tested, and implemented an energy-auditor-training curriculum which is now being used in training energy auditors. The two- to four-day curriculum was developed to make extensive use of the contents of the DOE document, Instructions for Energy Auditors. It was presented to and evaluated by the participants at the State Energy Audit Impact '79 Conference held in Dallas, Texas, during March, 1979. The curriculum was also seal tested at a two-day energy-auditor-training workshop conducted in Salt Lake City, Utah. Also, the curriculum was evaluated by a sample of state energy offices. Incorporation of all evaluator recommendations into the curriculum yielded a comprehensive energy-auditor-training curriculum. Through careful planning with the DOE, the curriculum contains materials for training Class A auditors as well as material for training auditors working in the DOE NECPA program.

27373 **Industrial-energy-auditor training.** Willis, G.W. Jr. (Texas A and M Univ., College Station). pp 4p, Paper 16 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

The latest program for technical training to aid engineers in performing energy audits at Texas A and M is described. Some of the background of the program is presented along with the future course schedules. A course outline is included in the appendix.

27374 **Energy-auditor training.** Karachiwala, B.Z. pp 4p, Paper 17 of State energy audit impact '80 conference. Norcross, GA; American Inst. of Industrial Engineers (1980).

From State energy audit impact '80 conference; St Louis, MO, USA (31 Mar 1980).

Iowa's establishment of a hierarchy of energy auditors is proving effective. The highlight of the auditor training program is the Energy Policy Council's Class A program. Public credibility in building energy conservation depends on the quality of the auditor. The proper training and selection of an energy auditor are crucial to all building energy-conservation programs.

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

27375 (CONF-791082—(Summ.), pp 289-293) **Overview of vehicle systems: comments.** Chesnes, A. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The main goal of the Program is to provide the linkage between advanced heat engine technology development and technology use leading to accelerated commercialization. Eight programs in the DOE Automotive Technology Development Division are: intercity and urban gas turbine bus demonstrations; turbocompound diesel truck demonstration; Rankine bottoming cycle development; controlled speed accessory drive demonstration; advanced transmission development; diesel emission technology; and technology assessments.

INTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 27428, 27429, 27430, 27431, 27432, 27433, 27434, 27435

27376 (DOE/ET/15397—T1) **Technical progress report for application of numerical simulation methodology to automotive combustion.** (Science Applications, Inc., La Jolla, CA (USA)). 5 Dec 1979. Contract AC03-79ET15397. 19p. NTIS, PC A02/MF A01.

The second quarterly technical progess report is presented for DOE Contract No. DE-AC-03-79-ET15397.001 entitled, Application of Numerical Simulation Methodology to Automotive Combustion. Technical studies have been initiated on the following task areas: parametric studies of induction and compression stroke effects; chemistry model development; turbulence transport model development; reactive turbulence model development; and numerical development studies. This work is summarized.

27377 (DOE/ET/15397—T2) **Technical progress report for application of numerical simulation methodology to automotive combustion.** (Science Applications, Inc., La Jolla, CA (USA)). Mar 1980. Contract AC03-79ET15397. 27p. NTIS, PC A03/MF A01.

The third quarterly technical progress report is presented for DOE Contract No. DE-AC-03-79-ET15397.001 entitled, Application of Numerical Simulation Methodology to Automotive Combustion. Work during the period has concentrated on completing the model development and validation for in-cylinder fluid dynamics via: simulation (and data comparison) for piston induced vortex roll-up at high Reynolds number; simulation (and data comparison) for the decay of swirl in the Sandia DISC engine; and definition of compression cycle parametric cycle simulations. The results of these studies are described.

SPARK-IGNITION

REFER ALSO TO CITATION(S) 27443

DIESEL

REFER ALSO TO CITATION(S) 27436, 27437, 27438, 27439, 27444, 27445

27378 (CONF-791082—(Summ.), pp 321-334) **Report on vehicle testing of the Cummins turbocompound diesel engine.** Werner, J. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The viability concept and the ability of Cummins Research and Engineering to model the turbocompound diesel engine have been proven. Two engines are being evaluated. The turbocompound diesel engine is built on a Cummins NTA-400 base engine and has been installed in a vehicle with a dual loop cooling system. The engine complies with the six gram (NO/sub x/ + UHC) emissions requirement of the 1980 California regulations. Dynamometer test results are reported.

27379 (CONF-791082—(Summ.), pp 335-343) **TARADCOM engine research and development overview.** Glance, P. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Development of the adiabatic diesel with good power density and good fuel economy for combat vehicle applications is discussed. The turbocharged reciprocating engine with a second stage turbine geared to the crankshaft is limited and needs no forced cooling.

27380 (CONF-791082—(Summ.), pp 344-358) **Adiabatic engine research and development program.** Bryzik, W. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Development of the adiabatic diesel engine is discussed and its efficiency as compared to a current diesel is noted. For a power level of 500 HP at 1900 rpm, a brake specific fuel consumption of 0.28 and a minimum life of 250 hours are targeted. The adiabatic demonstration engine will not need forced cooling and will be insulated. Elimination of conventional engine cooling has further

positive effects on military vehicle systems because of the attendant improved reliability, maintainability, and survivability characteristics. Many schematics of the engine are presented.

27381 (CONF-791082—(Summ.), pp 388-391) **New initiatives for fiscal year 1980.** Migra, R.P. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The DOE Vehicle Systems Program plans to initiate two new projects. The uncooled turbocompound diesel truck demonstration (1980) and the alternate fuels demonstration (1982) are described. The uncooled turbocompound diesel truck project is to develop the technology for and demonstrate the fuel economy of this advanced turbocompound engine in actual revenue service. Noise and emission levels for this engine will be established. The alternate fuels project will demonstrate the fuels capability of the Detroit Diesel Allison GT-404-4 gas turbine by operating intercity (Greyhound) and intracity buses on ethanol.

27382 (CONF-791082—(Summ.), pp 393) **Review of DOE role in diesel research.** Themak, H. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

In November 1977, EPA notified DOE that diesel particulate emissions had been shown to be mutagenic and potentially carcinogenic. The DOE research program on diesel engines supplements the research efforts at EPA, DOT, and the auto industry as well as to offer DOE management an assessment of the problem and to supply basic knowledge in areas where it is mutually agreed between government and industry engineers that there are gaps in the technology.

27383 (CONF-791082—(Summ.), pp 394-398) **Diesel emissions control technology: project update.** Willis, E.A. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Progress is reported on the diesel emission control research to contribute to a technology base for an independent DOE assessment of LDV diesel environmental acceptability, provide particulate filter samples for chemical characterization by others, and contribute technolgy and data to enhance industry development of advanced LDV diesels meeting 1983 and potential future standards. Experiments on the AVL Model single-cylinder research engine are briefly described.

27384 (CONF-791082—(Summ.), pp 399-413) **Diesel engine research and development status.** Roessler, W.U. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The fuel economy and exhaust emission characteristics of both production and experimental diesel engines and vehicles along with the effects of emission control systems on fuel economy and emission are summarized. Urban Cycle fuel economy data for diesel and SI engine-powered certification automobiles with manual and automatic transmissions are graphically presented. Diesel vehicle identification is represented. All diesel automobiles currently marketed use indirect injection engines.

27385 (CONF-791082—(Summ.), pp 414-428) **Fuel economy and exhaust emission characteristics of light-duty diesel vehicles.** Sturm, J.C. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The research program to determine the ability of various diesel technologies to improve fuel efficiency and exhaust emission characteristics and to provide exhaust particulate samples for DOE health effects research is described. Five prototypes (VW Turbo Rabbit, Fiat 131 NA, Fiat 131 turbocharged, Chrysler NA, Chrysler turbocharged) and one production (Oldsmobile Cutlass) vehicle were tested on a large roll chassis dynamometer to gain insight into the effects of engine turbocharging as compared to natural aspiration, exhaust gas recirculation for control of NO/sub x/, and the efficacy of exhaust oxidation catalysts in controlling HC and CO emissions (when injection timing is retarded to control NO/sub x/).

27386 (CONF-791082—(Summ.), pp 429-432) **Diesel particulate emissions.** Marshall, W.F. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The research project on particulate emissions from diesels is described. Effects of vehicle and engine design on production vehicles are examined and effects of ambient temperature, fuel composition, and vehicle duty cycle are studied. Routine analyses are made of emission of HC, CO, and NO/sub x/ and aldehyde formation and particulates. Detailed characterization of the particulate and associated organics was conducted and assessments of emissions control technologies were made.

27387 (CONF-791082—(Summ.), pp 433-438) **Status report on chemical and biological characterization of diesel exhaust emissions.** Royer, R.; Brooks, A. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Progress is reported on research to characterize how changes in engine type, fuel type, driving cycle, environmental conditions, and emissions control devices alter the chemical composition and biological activity of the organic materials associated with the exhaust particular aerosols.

27388 (CONF-791082—(Summ.), pp 439-442) **Emission control investigation for heavy-duty diesels.** Johnson, J.H. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Work performed on the emission control investigation for heavy-duty diesels is outlined. The tasks are: parametric evaluation tests with existing aftertreatment devices; lubricant and fuels evaluation; engine, fuel, and injection system modifications; and evaluation of advanced control techniques developed by EPA-ORD. Progress has been made in all tasks, but work reported for this period includes: 1979 Cat 3208 Engine, Engehard PTX catalysts, and 20" x 20" ultrahigh volume filter/blower procurred and installed; contracts for Mack ENDT 676 Engine and American Bosch APS Fuel System made; and studies for other aftertreatment approaches started.

27389 (CONF-791082—(Summ.), pp 454-456) **Research and policy implications of the substitution of diesel engines in future light-duty vehicles.** Barrington, L.F.B. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

A proposed study plan and organization on the technological, biomedical, environmental, energy, and economic aspects of the relevant research and public policy issues dealing with the implications of the substitution of diesel engines in future light-duty vehicles are described. Specifically, the biomedical effects of diesel engine emission, the applicable technologies of diesel engines, fuels, and emission controls; the environmental impacts of diesel technologies; the means for analyzing trade-offs between deleterious health and environmental effects and economic gains of diesel engine use; and the implications of these issues for public policies will be examined. Anticipated results are indicated.

27390 (CONF-791082—(Summ.), pp 473-484) **Utilization of alternate fuels in diesel engines.** Lestz, S.S. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Effective means of using alcohol and/or blends of used lubricating oil as the primary fuel in light-duty, high-speed, compression ignition automotive engine service were determined. Engine performance characteristics as a function of the amount of alcohol and/or used lubricating oil and the method by which is introduced were investigated. Fuel economy, exhaust emissions, and engine integrity are of prime interest. Single-cyclinder engine and constant volume combustion bomb work are used to provide support information.

TURBINE

REFER ALSO TO CITATION(S) 27427, 27500

27391 (CONF-791082—(Summ.), pp 113-120) **Alternate fuel gas turbine engine head start commercialization program.** Thur, G.M. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Congress is working on a commercialization bill (H.R. 4760). Research and technology aspects are being handled by the current DOE/NASA programs under PL-95-238. But an industry needs to be developed to handle the production when the engine is ready. The government, through H.R. 4760, can bring cash to a billion dollars into the industry through low interest loans for capital investment, energy conservation, public rebates, and subsidies. The third element toward commercialization is for the government to leverage or push gas turbines into a few selected application areas to establish at least a limited production base. Another sector of the market is military vehicles. A summary of the advantages and disadvantages of gas turbine and diesel engine is given.

27392 (CONF-791082—(Summ.), pp 121-142) **Advanced gas turbine power system development project: Detroit Diesel Allison/Pontiac Division of General Motors.** Helms, H.E. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Development of the project by Detroit Diesel Allison Division of General Motors to develop an experimental powertrain system is summerized. The Pontiac Phoenix 1984 X-body automobile has been selected as the demonstration vehicle. A Hydra-Matic four-speed transmission with converter clutch will be the transmission

used. A Delco Electronics Control System, using a basic automotive electronic control to be introduced in early 1980 General Motors cars, will be modified to service the turbine engine. Harrison Radiator Division will supply the regenerator system for the engine. The Corning Glass Company (regenerator disks and other parts), the Carborundum Company (most hot flow path parts), and the GTE Sylvania Company (ceramic rotors - silicon nitride) will supply the ceramic components. Key elements of the project are the development of small ceramic turbine engine components; low flow, variable geometry, efficient aerodynamic components; and a gas turbine engine powertrain which is affordable in a production environment.

27393 (CONF-791082—(Summ.), pp 143-164) **Advanced gas turbine power system development project: AiResearch/Ford.** Rackley, R.A. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Advanced Gas Turbine (AGT) Powertrain System Development Program initiated by AiResearch/Ford Motor Company is described. A single-shaft gas turbine, using ceramic high temperature components, will be developed in conjunction with a drivertrain utilizing a split-path differential reduction gear and variable-stator torque converter coupled to a production, four-speed transmission. The powertrain will be designed for a 1984 Ford rear-wheel-drive automobile similar to the 1980 Ford Fairmont. When completed in 1985, this AGT-powered vehicle is expected to achieve a Combined Federal Driving Cycle (CFDC) rating of 36.0 mpg of gasoline. When converted to diesel fuel, this is equivalent to about 42 mpg, the same fuel economy as projected for the GM AGT power system.

27394 (CONF-791082—(Summ.), pp 165-176) **Advanced gas turbine power system development project: panel discussion.** Huebner, G. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Panelists directed their discussions toward the following: are the fuel economy improvements being sought realistic and are the project goals agreeable; with the ultimate objective being commercialization, should the industry convert to an alternative power plant that is successfully developed; are the component performance and material developments required for the AGT project realistic in the time frame of the project; and make suggestions for either contractor to enhance his changes of success.

27395 (CONF-791082—(Summ.), pp 183-191) **Investigation of the interstage duct and its effect on power turbine performance.** McLallin, K.L. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The aerodynamic performance of the power turbine from an upgraded engine is being determined in a component test rig. Specifically, the effects of variable stator setting position, stator end clearances, rotor tip clearances, turbine Reynolds number, and interstage ducting on power turbine aerodynamic performance are being investigated. The program objective is to demonstrate a 50% improvement in fuel economy over baseline technology, meet mandatory pollution standards, and maintain driveability in a gas turbine powered automobile. The aerodynamic performance of turbomachinery and associated ducting are being determined in component rig tests. The test rig includes the interstage duct, turbine blading, and exit diffuser. The pre-rotation vanes provide design swirl into the interstage duct. The effects of various design features on power turbine performance which will be determined are: interstage duct, variable stator setting position, stator end clearances, rotor tip clearance, and turbine Reynolds number.

27396 (CONF-791082—(Summ.), pp 192-208) **Ceramic applications in turbine engines.** Rockwood, F.A. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Detroit Diesel Allison Division of General Motors is conducting research on the application of ceramic components to demonstrate improved cycle efficiency by raising the operating temperature of the existing Allison GT-404 vehicular gas turbine engine. The status of activities with the initial configuration at 1900°F.T.I.T. is reported. The 2070 F engine design configuration and ceramic components are described with its features identified: individual ceramic vanes and ceramic blades in metal rotor; vane row isolated from mechanical loads; and abradable turbine tip shroud.

27397 (CONF-791082—(Summ.), pp 209-213) **Status of the Ford Program to develop ceramic regenerator systems for gas turbines.** Fucinari, C.A. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The tasks in the NASA/Ford program to improve the durability of rotary ceramic heat exchangers are: core durability hours at 800°C (5 cores have 10,000 hours); core durability hours at 1000°C (4 cores have 5000 hours); material screening tests; performance tests in shuttle rig; design of advanced regenerators; material stability tests (1000, 1100, and 1200°C); cost study update; material specification (800 and 1000°C); project management; technical reports. Results of the core durability hours at 800 and 1000°C, performance tests in shuttle rig, and material stability tests are briefly described.

27398 (CONF-791082—(Summ.), pp 214-241) **Status of the Ford program to evaluate ceramics for one-piece stator applications in gas turbine engines.** Trela, W. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The stator fabrication task currently includes 4 separate suppliers for the following: injection-molded SI_3N_4; injection-molded SiC; slip-cast Si_3N_4; and slip-cast SiC. The discussion covers stator design and fabrication, stator evaluation, and some experimental results, specificially on durability cycling.

27399 (CONF-791082—(Summ.), pp 242-253) **Durability testing of ceramic materials for automotive gas turbine engines.** Carruthers, D. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Four commercially available ceramic materials were evaluated under extended cyclic thermal exposures up to 2500°F and 3500 hours. The materials are Norton NCX-34 hot-pressed silicon nitride; AiResearch Air Ceram 101 reaction-bonded silicon nitride (ACC RBN101); Carborundum pressureless sintered SiC; and Pure Carbon CO (British Nuclear Fuels, Ltd.) REFEL siliconized carbide. Progress to date includes procurement of test materials, design and fabrication of air-cooled specimen holders and burner rigs, completion of baseline testing and 350-, 1050-, and 2100-hour exposures, and initiation of 3500 cyclic and 1050-hour isothermal exposures. Test results are discussed.

27400 (CONF-791082—(Summ.), pp 254-262) **Development of high performance sintered Si_3N_4.** Greskovich, C.D. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Generating sintering knowledge pertinent to Si_3N_4 ceramics, developing a sinterable composition of Si_3N_4 with improved high temperature properties, and evaluating microstructures and properties of sintered Si_3N_4 ceramics useful for thermomechanical applications are discussed. Future plans on this activity are presented.

27401 (CONF-791082—(Summ.), pp 263-275) **Ceramic life prediction: tensile and flexural stress rupture data for hot-pressed silicon nitride, NC-132.** Govila, R.K. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

A total of 16 tensile stress-rupture specimens were tested at 1204°C at various stress levels and 16 flexural stress-rupture specimens of NC-132 from three different billets were tested at 1204°C at two different stress levels. The results are presented.

27402 (CONF-791082—(Summ.), pp 276-287) **Durability behavior of structural ceramics.** Quinn, G.D. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Candidate turbine ceramics were studied to obtain data on long-term exposure in oxidizing environments (under load) and data on retained strength of ceramics after exposure to combined oxidation and thermal cycling. The six silicon nitride and 7 silicon carbide materials were subjected to emission spectrographic chemical analysis, x-ray diffraction phase analysis, density measurements, and room temperature modulus of rupture testing. Results of the stress rupture testing at 1200°C, stepped temperature stress rupture tests, and combined cycle testing are discussed.

27403 (CONF-791082—(Summ.), pp 294) **Status of intercity bus demonstration project.** Stieber, J. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The status of the demonstration project to evaluate heavy-duty gas turbine engines in buses is described. Coaches will operate between different city pairs around the country for maximum environmental and data input on a geographical basis. The first test involved a run from North Dakota to Washington, DC via Sandusky, Ohio. Observations on that run are briefly noted.

27404 (CONF-791082—(Summ.), pp 295-298) **Gas Turbine Transit Bus Demonstration Program.** Ross, R.J. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The accomplishments to date of the demonstration program to evaluate gas turbine engines in advanced design transit buses under actual service conditions are: installation design essentially complete; first conversion 90%, second conversion 40% complete; engine deliveries 50% complete; acceptance, performance, and systems test plans written; alternative fuels and revenue service demonstration plans written.

27405 (CONF-791082—(Summ.), pp 443-453) **Survey of particulate sampling techniques.** Duleep, K.G. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Research on sampling and characterization techniques for automotive particulate emissions was conducted to: understand the particulate formation process and the rationale behind any particulate sampling techniques; identify the various unspecified parameters in EPA's draft recommended practice with reference to in-use practices; and determine the effects of these parameters on the type and amount of particulate emission collected for measurement. Data are tabulated comparing results obtained using glass fiber and teflon coated glass fiber filters.

27406 (DOE/NASA/0008—79/10) **Feasibilty study of silicon nitride regenerators.** Fucinari, C.A.; Rao, V.D.N. (Ford Motor Co., Dearborn, MI (USA)). Oct 1979. Contract AI01-77CS51040. 58p. (NASA-CR—159713). NTIS, PC A04/MF A01.

The feasibility of silicon nitride as a regenerator matrix material for applications requiring inlet temperatures above 1000°C is examined. Using the present generation oxide ceramics as a reference, silicon nitride was examined from a material characteristics, manufacturing, thermal stress and aerothermodynamic viewpoint.

27407 (DOE/NASA/0043—2) **High temperature self-lubricating coatings for air lubricated foil bearings for the automotive gas turbine engine.** Bhushan, B. (Mechanical Technology, Inc., Latham, NY (USA)). Apr 1980. Contract AI01-77CS51040. 33p. (NASA-CR—159848; MTI—79TR76). NTIS, PC A03/MF A01.

The objective of this program was to further develop the coating combinations identified in a previous program for compliant surface bearings and journals to be used in an automotive gas turbine engine. The coatings should be able to withstand the sliding start/stops during rotor lifetoff and touchdown and occasional short-time, high speed rubs under representative loading of the engine - 14 kPa and at 35 kPa if possible, and at a maximum temperature of 427 to 650°C. Some dozen coating variations of CdO-graphite, Cr^2O_3 (by sputtering) and CaF_2 (plasma sprayed) were identified. The coatings were optimized and they were examined for stoichiometry, metallurgical condition, and adhesion. Sputtered Cr_2O_3 was most adherent when optimum parameters were used and it was applied on an annealed (soft) substrate. Metallic binders and interlayers have been used to improve the ductility and the adherence. The following coating combinations have satisfied the above requirements: CdO-graphite-Ag (HL-800-2)/sup TM/ on foil versus det. gun Cr_3C_2 good up to 427°C and sputtered Cr_2O_3 versus det. gun Cr_3C_2 good from RT to 427 to 650°C.

EXTERNAL COMBUSTION ENGINES

STIRLING CYCLE

27408 (CONF-791082—(Summ.), pp 11-14) **Stirling engine program overview.** Lombardi, P.V. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The intent of the DOE ongoing Stirling program is briefly discussed. One of the major program objectives is to develop kinematic Stirling engine technology from a strong technology base and transfer that technology to the US and the American automotive industry. The commitment being made at the research level on the Stirling engine is briefly reviewed.

27409 (CONF-791082—(Summ.), pp 15-26) **Stirling engine component and development status.** Nightingale, N. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Progress is reported on the MTI Stirling engine program. To date the following major program objectives have been achieved: initial technology assessment completed; reference engine system design redirected to a front-wheel drive vehicle; P-40 engine tested successfully in the US; P-40 Spirit vehicle demonstrated 18% better fuel economy than the P-40 Opel; and engine drive system rig testing started at Ricardo.

27410 (CONF-791082—(Summ.), pp 27-39) **Automotive Stirling engine component development.** Holgersson, S. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Development on Mod I and Mod II components is reported. Mod I is based on United Stirling's existing P-40 engine technology to improve engine power-to-weight ratio (58 kW engine) and Mod II is to further improve engine performance. Test results on elevated heater temperature, piston rod seal, heater design, and the Mod I combustor are reported.

27411 (CONF-791082—(Summ.), pp 40-60) **Stirling engine drive systems test rig.** Crouch, A.R. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Testing to achieve a quieter coupling arrangement between the two crankshafts and the main drive shaft in the U form Stirling-powered engine is reported. The test unit is based on a P-40 crankcase, modified to accept new crankshafts, main drive shafts, front and rear spacer plates, and a sump adaptor plate.

27412 (CONF-791082—(Summ.), pp 61-71) **Stirling engine vehicle integration.** 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

AM General is responsible for integration of the Stirling engine into passenger vehicles. This includes the engine mounting, the cooling and exhaust systems, the electronics systems mounting, the instrumentation, the hydrogen reservoir, and all drive train components. The P-40 engine was adapted to automotive use and tests were run on the P-40/Opel for emissions, fuel economy, and performance. The P-40 Spirit was tested for emissions, fuel economy, and road performance and then modified to improve performance. Test results are presented.

27413 (CONF-791082—(Summ.), pp 72-78) **Stirling Laboratory research engine.** Hoehn, F.W. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The configuration of the SLRE includes a horizontally opposed, two-piston, single-acting Stirling prime mover with a dual crankshaft drive mechanism. Engine starting requirements and energy balance are discussed.

27414 (CONF-791082—(Summ.), pp 79-85) **Stirling engine materials technology.** Stephens, J.R. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The materials program is concentrating on high-temperature components that are most critical to the successful employment of the Stirling engine for automotive purposes, centering on high operating temperatures and a hydrogen working fluid, making the heater head tubes and the cast cylinder/regenerator housings the most critical. Hydrogen permeability in heater tubes is discussed. It is concluded that H_2 doped with CO_2 permeates most candidate tube alloys at a lower rate than for undoped hydrogen. Lowest rates are experienced by those alloys that contain reactive metal additions such as Al and Ti. Aging in hydrogen or testing in hydrogen results in a subsequent reduction in high temperature creep properties and in room temperature ductility.

27415 (CONF-791082—(Summ.), pp 86-98) **Hydrogen permeability in uncoated and coated metals.** Vesely, E.J. Jr. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Research involves 4 tasks. Tasks II and III have been completed. Task II involves the determination of permeability of hydrogen for N-155 coated with 4 different coatings. These coatings are Si_3N_4, S6100M glass, high-density Al_2O_3, and an HWS 25000 aluminide. Task III required the determination of permeability, diffusivity, and solubility of 4 iron-base alloys (N-155, Incoloy 800, 1909DL, and A-286) at 1200 to 1500 F in 3000 psi hydrogen containing one v/o CO or one v/o CO_2.

27416 (CONF-791082—(Summ.), pp 99-107) **Analysis of rod seal lubrication for Stirling engine application.** Krauter, A.I. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Applying hydrodynamic and elastohydrodynamic theory to a sliding elastomeric rod seal for the Stirling engine is reported. Film thickness fluid leakage, and power loss are determined experimentally. Experimental and theoretical results are correlated.

27417 (CONF-791082—(Summ.), pp 108-111) **Structured audience discussion of stirling engine program.** Ragsdale, R.G. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Six questions are posed, the corresponding DOE/NASA position is stated, and comments from the audience are summarized. The questions are: what are the key technical problems; what characteristics of Stirling engines would most enhance industry acceptance; how do you go all the way to commercialization; what would get industry as interested in Stirling as it is in gas turbines; is Stirling or gas turbine more likely to meet our program objectives; and will a 30% improvement in fuel economy be a sufficient motivating factor for the automotive industry to consider Stirling engines for automobile application and if not, what percent is considered sufficient.

RANKINE CYCLE

27418 (CONF-791082—(Summ.), pp 299-320) **Status of diesel organic-Rankine compound engine for long-haul trucks.** Doyle, E. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The status of the program to develop and demonstrate a completely integrated compound engine, consisting of a diesel engine coupled to a Rankine engine, which operates on the exhaust heat from the diesel engine, is presented. The prototype compound engine is built around a standard Mack Truck diesel engine, and the waste heat recovery system is a Thermo Electron organic-Rankine bottoming cycle system incorporating a turbine expander delivering power to the diesel engine drive train. Test results are reported on the system functional checkout; calibrated diesel engine check-point and compound engine baseline system with chassis-mounted dynamometer; and road test.

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 27254, 27422, 27423

27419 (DOE/NASA/1044—7) **Electric vehicle propulsion system's impact on battery performance: an overview.** Bozek, J.M.; Smithrick, J.J.; Cataldo, R.C.; Ewashinka, J.G. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1980. Contract AI01-77CS51044. 11p. (NASA-TM—81515; CONF-800523—3). NTIS, PC A02/MF A01.

From 3. international electric vehicle exposition and conference; St. Louis, MO, USA (May 1980).

The performance of a battery may depend heavily on the demands of the electric vehicle's propulsion system during charge and discharge. At the NASA's Lewis Research Center the performance of two types of batteries, lead-acid and nickel-zinc, was measured as a function of the charging and discharging demands anticipated from electric vehicle propulsion systems. The benefits of rapid high current charging are mixed: Although it allows quick charges, the energy efficiency is reduced. For low power (overnight) charging the current wave shapes delivered by the charger to the battery cycle life. The use of chopper speed controllrs with series traction motors results in a significant reduction in the energy available from a battery whenever the motor operates at part load. The demand placed on a battery by an electric vehicle propulsion system containing electrical regenerative braking has conirmed significant improvement in short-term performance of the battery. These results have identifed strong short-term interactions between an electric vehicle propulsion system and the battery. Since there is no information on the long-term effects of these interactions, a series of research projects are under way to determine effects of these interactions on the cycle life of a battery.

27420 (UCRL—52933) **Comparative analysis of aluminum-air battery propulsion systems for passenger vehicles.** Salisbury, J.D.; Behrin, E.; Kong, M.K.; Whisler, D.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Feb 1980. Contract W-7405-ENG-48. 103p. NTIS, PC A06/MF A01.

Three electric propulsion systems using an aluminum-air battery were analyzed and compared to the internal-combustion-engine (ICE) vehicle. The analysis used projected battery characteristics extrapolated from laboratory measurements which were obtained in late 1979 and early 1980. In the analysis, the engine and fuel systems of a representative five-passenger highway vehicle were replaced conceptually by each of the three electric propulsion systems. The electrical vehicles were constrained by the computer simulation to be equivalent to the ICE vehicle in range and acceleration performance. The vehicle masses and aluminum consumption rates were then calculated for the electric vehicles and these data were used as figures of merit. The Al-air vehicles analyzed were: (1) an Al-air battery-only electric vehicle, (2) an Al-air battery combined with a nickel-zinc secondary battery for power leveling and regenerative braking, and (3) an Al-air battery combined with a flywheel for power leveling and regenerative braking. Projected Al-air battery power density, energy density, mass, and volume characteristics were based on recent experimental results of the Al-air battery development program at Lawrence Livermore Laboratory. All three electric systems compared favorably with the ICE vehicle.

HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 27420

27421 (CONS—4209-T1(Vol.2)) **Hybrid vehicle potential assessment. Volume 2. Mission analysis.** Surber, F.T.; Deshpande, G.K. (Jet Propulsion Lab., Pasadena, CA (USA)). 30 Sep 1979. Contract EM-78-I-01-4209. 84p. NTIS, PC A05/MF A01.

Seven vehicle missions were selected and defined for use in assessing hybrid vehicle concepts and are summarized. These missions were selected to provide general coverage of current and future vehicle uses and classes. Their travel pattern definitions are based primarily on analysis of the 1969 National Personal Transportation Study travel data. Performance requirements are based on current highway designs and speed limits and the results of studies of performance requirements for safe and non-interfering operation in today's traffic environment. The mission definitions are independent of vehicle technology so even though they were selected and defined for use in assessing hybrid vehicles, they could also be used in assessing the potential of other vehicle technologies such as electric vehicles, turbo-charging, Stirling engines, etc.

27422 (DOE/EA—0108) **Inclusion of electric and hybrid vehicles in corporate average fuel economy standards.** (Department of Energy, Washington, DC (USA). Office of Transportation Programs). May 1980. 48p. NTIS, PC A03/MF A01.

This environmental assessment (EA) examines the probable maximum impact of commercialization of electric and hybrid electric vehicles (EHV) through calendar year 1986 as a result of EHV commercialization attributable to the proposed action to include electric vehicles in petroleum-equivalent corporate average fuel economy computations during the evaluation period ending January 1, 1987. The impact analysis is based on the programmatic environmental assessment for electric and hybrid vehicles scheduled for release in late 1980. The present EA is based on a projection that just under 100,000 EHVs will be on the road on January 1, 1987. The expected on-road total represents only 0.066% of the forecasted 1986 total highway vehicle stock. The affected environments, possible long- and short-term impacts, the comittment of resources, and the impacts relative to alternatives to EHV's are discussed. It is concluded that no significant impact on the human environment will result from the maximum likely production and operation of EHVs attributable to the proposed action, and any expected impacts will be mitigated through regulated controls. Based on the EA analysis of the potential environmental impacts of the proposed action, it is recommended that a finding of no significant impact be tendered. (LCL)

27423 (DOE/NASA/0078—79/1) **Study of advanced electric propulsion system concept using a flywheel for electric vehicles.** Younger, F.C.; Lackner, H. (Brobeck (William M.) and Associates, Berkeley, CA (USA)). Dec 1979. Contract AI01-77CS51044. 261p. (NASA-CR—159650; WMB-A—4500-131-3-R1). NTIS, PC A12/MF A01.

A study for evaluation of advanced electric propulsion system concepts with flywheels for electric vehicles predicts that advanced systems can provide considerable performance improvement over existing electric propulsion systems with little or no cost penalty. Using components specifically designed for an integrated electric propulsion system avoids the compromises that frequently lead to a loss of efficiency and to inefficient utilization of space and weight. A propulsion system using a flywheel energy storage device can provide excellent acceleration under adverse conditions of battery degradation due either to very low temperatures or high degrees of discharge. Both electrical and mechanical means of transfer of energy to and from the flywheel appear attractive; however, development work is required to establish the safe limits of speed and energy storage for advanced flywheel designs and to achieve the optimum efficiency of energy transfer. Brushless traction motor designs using either electronic commutation schemes or dc-to-ac inverters appear to provide a practical approach to a mass producible motor, with excellent efficiency and light weight. No comparisons were made with advanced system concepts which do not incorporate a flywheel.

27424 (DOE/NASA/0091—80/1) **Advanced propulsion system for hybrid vehicles.** Norrup, L.V.; Lintz, A.T. (AiResearch Mfg. Co., Torrance, CA (USA)). Jan 1980. Contract AI01-77CS51044. 214p. (NASA-CR—159771; AIRESEARCH—79-16430). NTIS, PC A10/MF A01.

The objective of this study was to evaluate a number of hybrid propulsion systems for application in several different vehicle sizes. A conceptual design was prepared for the most promising configuration. The program was divided into several tasks during which the various system configurations were parametrically evaluated and compared, design tradeoffs performed, and a conceptual design produced. Fifteen vehicle/propulsion system concepts were parametrically evaluated to select two systems and one vehicle for detailed design tradeoff studies. A single hybrid propulsion system concept and vehicle (five-passenger family sedan) were selected for optimization based on the results of the tradeoff studies. The final propulsion system consists of a 65-kW spark-ignition heat engine, a mechanical continuously variable traction transmission, a 20-kW permanent magnet axial-gap traction motor, a variable frequency inverter, a 386-kg lead-acid improved state-of-the-art battery, and a

transaxle. The system was configured with a parallel power path between the heat engine and battery. It has two automatic operational modes: electric mode and heat engine mode. Power is always shared between the heat engine and battery during acceleration periods. In both modes, regenerative braking energy is absorbed by the battery. In the electric mode the battery (80% depth of discharge) provides an electric range of 218 km, when it is using petroleum at the rate of 30 km/liter. In the heat engine mode the mileage is 14 km/liter. The propulsion system has a life-cycle cost of $0.054/km. The vehicle has a test weight of 2032 kg and can accelerate from 0 to 90 km/hr in 12 s. It has a top speed of 105 km/hr and a steady-state hill climbing capability of 90 km/hr on a four percent grade.

FLYWHEEL PROPULSION

REFER ALSO TO CITATION(S) 27420, 27423

27425 (UCRL—15164) **Laminated, composite flywheel failure analysis.** Nimmer, R.P. (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 6 Jun 1980. Contract W-7405-ENG-48. 37p. NTIS, PC A03/MF A01.

A hybrid, composite flywheel, composed of a laminated, flat S2-glass central disc, with a filament wound, graphite outer ring, has been proposed for vehicle application. The failure mechanism of the laminated central disc of this hybrid design is discussed with reference to spin test data, nondestructive ultrasound test data, and supporting failure analysis.

27426 (UCRL—15231) **Fabrication of two one-fifth scale fiber composite flywheels. Final report.** (Brobeck (William M.) and Associates, Berkeley, CA (USA)). Apr 1980. Contract W-7405-ENG-48. 43p. NTIS, PC A03/MF A01.

Two fiber-composite flywheel rotors were fabricated. These flywheels are scaled-down versions of two automotive flywheels built for Sandia Laboratories. The design fabrication of the scaled-down versions was necessitated by the limitations imposed on the testing of the 5 kWh prototypes at the Oak Ridge Flywheel Evaluation Laboratory. The flywheels store a maximum of 0.97 kWh of kinetic energy. Energy density is 87 Wh/kg at the maximum operating speed of 56,000 rpm. The nominal flywheel dimensions are 35 cm diameter by 13 cm axial height. The weight of the flywheel rotor assembly is 11.16 kg.

VEHICLE DESIGN FACTORS

REFER ALSO TO CITATION(S) 27334

EMISSION CONTROL

REFER ALSO TO CITATION(S) 27385, 27386, 27387, 27388, 27389, 27390, 27405

27427 (CONF-791082—(Summ.), pp 177-182) **Comparative emission characteristics of a diffusion flame and a premixed prevaporized combustor.** Juhasz, A.J. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

In a continuing program to improve combustor performance, particularly with regard to pollutant reduction, exhaust emission measurements were conducted on two upgraded gas turbine engines. One engine was equipped with a droplet diffusion combustor similar to that of the baseline engine, and the second used a more up-to-date premixed prevaporized combustor. Both engines operated on indoline fuel. Emissions of HC, CO, and NOx were measured by using a water-cooled probe. Engine component parameters directly affecting emission levels were combustor exit temperature (gas generator turbine inlet temperature), which increases with gas generator speed, and power turbine exit temperature, which is controlled at 1380°F by the power turbine inlet guide vane angle.

27428 (CONF-791082—(Summ.), pp 374-387) **Conventional engine technology for automotive application.** Dowdy, M. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The emissions and fuel economy regulations which have led to significant changes in automotive technology in recent years are reviewed. Some fuel economy data are graphically represented for the UC Otto 3-way catalyst, SC Otto, rotary, diesel, and ATSP baseline 4-speed manual transmission engines. General conclusions drawn from looking at conventional engine technology for automotive applications are that: uniform charge Otto engines with 3-way catalyst emission control systems have potential to meet present and future emissions standards with little fuel economy penalty; prechamber diesel engines have fuel economy advantages if NO/sub x/ and particulate emissions can be controlled and if diesel particulates prove not to be carcinogenic; and additional fuel economy advantages can be achieved with the development of stratified charge and diesel engines of the open chamber configuration.

27429 (CONF-791082—(Summ.), pp 459-472) **Alcohol fuels for highway vehicles: panel discussion.** Ecklund, E.E. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Four panelists described research at their respective facilities dealing with alcohol fuels. Areas covered were: performance and emissions characteristics of alcohol fuel blends in engines; effects of alcohol-containing fuels on engine lubrication and wear; fleet vehicles operating on gasohol; 10% methanol, indolene, indolene plus 10% methanol, and indolene plus 10% ethanol plus other additives. Activities at the University of Santa Clara include alcohol-fueled vehicles, cold starting experiments, Toyota Supra blend tests, thermokinetic modeling of aldehyde formation, smog chamber comparisons of alcohol and gasoline, exhausts, and environmental toxicity comparisons.

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 27052, 27334, 27335

27430 (ALO—3682-T1) **Modifications for use of methanol or methanol-gasoline blends in automotive vehicles, September 1976-January 1980.** Patterson, D.J.; Bolt, J.A.; Cole, D.E. (Michigan Univ., Ann Arbor (USA). Dept. of Mechanical Engineering). Jan 1980. Contract AC04-76CS53682. 194p. NTIS, PC A09/MF A01.

Methanol or blends of methanol and gasoline as automotive fuels may be attractive means for extending the nation's petroleum reserves. The present study was aimed at identifying potential problems and solutions for this use of methanol. Retrofitting of existing vehicles as well as future vehicle design have been considered. The use of ethanol or higher alcohols was not addressed in this study but will be included at a later date. Several potentially serious problems have been identified with methanol use. The most attractive solutions depend upon an integrated combination of vehicle modifications and fuel design. No vehicle problems were found which could not be solved with relatively minor developments of existing technology providing the methanol or blend fuel was itself engineered to ameliorate the solution. Research needs have been identified in the areas of lubrication and materials. These, while apparently solvable, must precede use of methanol or methanol-gasoline blends as motor fuels. Because of the substantial costs and complexities of a retrofitting program, use of methanol must be evaluated in relation to other petroleum-saving alternatives. Future vehicles can be designed initially to operate satisfactorily on these alternate fuels. However a specific fuel composition must be specified around which the future engines and vehicles can be designed.

27431 (CONF-791082—(Summ.), pp 485-489) **Grain alcohol motor fuel: technology and economics.** Moon, G.D. Jr. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

An evaluation was made of the technical and economical feasibility for production of grain motor fuel ethyl alcohol from a grass roots plant with a capacity of 50 million US gallons per year. The base case evaluation included a detailed process design using proven technology, a complete budget estimate of the plant investment including working capital, a detailed analysis of the annual operating cost using corn as the primary feedstock, and complete financial analysis which established the alcohol selling price required to net, to the investor, a 15% discounted cash flow (interest rate of return).

27432 (CONF-791082—(Summ.), pp 490-492) **Reliability fleet testing of alcohol/gasoline blends.** Raymond, R.D. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The near-term goal of the Reliability Fleet Test Program concentrating on alcohol fuels alternative is to bring the end-use technology for alcohol/gasoline blends to the point of commercial readiness. Initial tests are expected to begin soon.

27433 (CONF-791082—(Summ.), pp 493-494) **Controlled fleet tests.** Gunderson, J.A. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Emphasis in this portion of DOE's Alternative Fuels Utilization Program is on the chemical effects of gasoline/alcohol blends on emissions. Other than the main emphasis, other objectives are to evaluate evaporative hydrocarbon emissions, aldehyde exhaust emissions, ethanol and methanol exhaust and evaporative emissions,

vehicle driveability, vapor lock, and fuel economy. Fourteen 1980 production vehicles are to be utilized in the test.

27434 (CONF-791082—(Summ.), pp 495-498) **DOE reliability fleet test program for alcohol/gasoline fuels.** Tosh, J.D. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The projected schedule for the DOE Reliability Fleet Test Program is presented. A total of 13 fleets in 6 geographical areas is planned over a 4-year period. Basic formulations to be utilized include: 10% ethanol; 10% methanol; and a 10% blend of ethanol and methanol together. Ten Federal fleets totaling about 850 vehicles will be evaluated with the first such test being initiated in early FY 1980.

27435 (CONF-791082—(Summ.), pp 499-500) **National Alcohol Fuel Commission activity.** Gratch, S. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The commission is mandated to examine the alcohol fuels issue and to formulate concrete and workable recommendations for legislative and executive branch actions that will encourage development and commercialization of gasohol and other alcohol fuels. The organization of the committee is summarized.

27436 (CONF-791082—(Summ.), pp 501-507) **Overview of the alternative fuels for medium-speed diesel engines (AFFMSDE).** Foster, R.W. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Diesel engines operating with nominal speeds of 300 to 1000 rpm are medium speed engines finding use in marine, railroad, large-scale earth-moving equipment, power generating stations, industrial power systems, and on-shore and off-shore oil drilling equipment systems. The Project Management Plan is described. Its main objective is to explore the technical, business operations, and business economics impacts that would be encountered in the conversion from conventional, petroleum-based fuels to alternative, non-petroleum based fuel systems. Rail systems are emphasized, but problems encountered in other applications should be generally similar. Status of the Multi-Cylinder Engine Test Facility being constructed at Southwest Research Institute is reviewed.

27437 (CONF-791082—(Summ.), pp 508-515) **Alternate fuels for medium-speed diesels.** Baker, Q. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The research program with a two-cylinder, two-stroke cycle, medium-speed diesel engine operating on off-specification diesel fuels is described. Performance and emissions measurements have been completed for off-specification diesel fuels, emulsified heavy fuel, simulated coal-derived diesel fuel, and methanol. Data on engine test cycle and test fuels design are presented.

27438 (CONF-791082—(Summ.), pp 516-522) **Alternate fuels for railroad locomotive diesel engines.** Liddle, S.G. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

A review of the Future Propulsion Systems for Railroad Locomotives Project is presented. It briefly examines alternate fuels, their properties, and their uses in locomotive engines. The locomotive engine can operate satisfactorily on a wide range of fuels provided certain restrictions on cetane rating, viscosity, and lubricity are met. Blends of petroleum and non-petroleum fuels are most likely to be used in the near-term, and non-petroleum fuels similar to present-day diesel fuels will be used in the longer term.

27439 (CONF-791082—(Summ.), pp 523-527) **Use of hybrid fuels in a single-cylinder diesel engine.** Moses, C.A. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Experiments conducted in a single-cylinder diesel engine with water/fuel emulsions and alcohol/fuel blends (solutions and emulsions) are briefly described. Fuels are compared in terms of specific energy consumption, specific diesel fuel consumption (a measure of petroleum conservation), and specific cost. Limited engine experiments have been conducted with carbon and carbohydrate slurries and soluble carbohydrates. It is concluded that compression ignition engines can be operated satisfactorily on diesel fuel-dry ethanol solutions; ethanol-diesel fuel solutions are very water-sensitive; the alcohol emulsions are viable diesel engine fuels; and the use of slurry fuels appears to be possible.

27440 (CONF-791082—(Summ.), pp 542-551) **Development of lightweight hydrides.** Rohy, D.A. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The use of hydrogen as an energy carrier is dependent on the inexpensive production of hydrogen and lightweight storage of hydrogen. On-board storage is a basic limitation of hydrogen as an automotive fuel. Metal hydrides have the greatest potential to provide effective storage and magnesium-base alloys offer the best weight density. Research on magnesium-base alloys will continue and dual FeTi and magnesium alloy systems will be optimized in this program.

27441 (CONF-791082—(Summ.), pp 553-563) **Transportation fuels from shale oil.** Sullivan, R.F. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

A pilot plant refining study on surface retorted Paraho shale oil recently completed by Chevron is described. Three basic shale oil processing routes for the production of transportation fuels were studied: hydrotreating followed by hydrocracking; hydrotreating followed by fluid catalytic cracking; and severe choking followed by hydrotreating. A fourth alternate was evaluated in which raw shale oil was hydrotreated to produce a snythetic crude suitable for processing in an existing refinery. Product yields, product properties, and estimated process costs derived from the studies are summarized.

27442 (CONF-791082—(Summ.), pp 564-575) **An assessment of the potential for making various liquid fuels from shale oil and direct liquefaction coal liquids.** Singerman, G.M. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

The potential for making transportation, residential, and industrial fuels from direct liquefaction coal liquids and shale-derived liquids is examined with the following in view: properties of coal and shale derived liquids versus those of petroleum crudes; property requirements for the fuels; and refining improvements needed to process synthetic liquids in conventional petroleum refineries.

27443 (CONF-791082—(Summ.), pp 576-579) **Coal-derived fuels in a spark ignition engine.** Uyehara, O. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Transforming coal to liquid hydrocarbon requires the chemical addition of hydrogen. The coal-derived fuels for spark ignition engines must contain a higher proportion of aromatics, cyclo paraffin, and olefins with some paraffins. The fuel tested was synthesized for use as a typical coal-derived fuel showing a much higher proportion of aromatic, and tested in a spark-ignited, single-cylinder test engine. The fuel has a tendency to form engine deposits if it is fed to the engine via the normal carburetor or port injection fuel system. The test is briefly described and a deposit-measuring device has been installed in the combustion chamber to test various fuels.

27444 (CONF-791082—(Summ.), pp 580-583) **Improving low-temperature properties of shale-derived diesel fuels.** Frankenfeld, J.W. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

A program to evaluate the potential of additives for improving the low-temperature flow properties of synthetic diesel fuels derived from oil shale is described. Raw shale oil will be distilled into three different fractions representing a common (325°F) starting point and three different end points in the diesel fuel range. The fractions will be catalytically hydroprocessed at 3 different severities. The resulting nine fuels will be characterized and treated with a variety of additives. Initial response to additive treatment will be monitored by pour point determination. The best additive-fuel combinations will be further evaluated by a low temperature filterability test.

27445 (CONF-791082—(Summ.), pp 584-593) **Emergency fuels composition and impact.** Bailey, B.K. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Fluids chosen for evaluation as emergency diesel fuel constituents selected to represent a broad range of refinery product which might be available locally in reasonable quantities for emergency use are: gasoline, naphtha, jet fuel, kerosene, diesel fuel oil, distillate fuel oil, residual fuel oil, and crude oil. CAT 1H diesel test fuel was chosen as the reference and blending base fuel. The candidate fuels were evaluated by laboratory analysis, bench test, and limited engine testing.

27446 (CONF-791082—(Summ.), pp 594-603) **Identification and evaluation of optimized alternative fuels.** Sefer, N.R. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

A project to identify and evaluate optimized alternative fuels for highway transportation is described. Development of three regional refinery models to predict fuel compositions and qualities in 1995 is planned. Shale oil and coal oil syncrudes from 5 generic processes will be used. Three product slates are conventional fuels, maximum diesel fuels, and a broadcut fuel. Fuel supplement options include methanol, ethanol, methyl-t-butyl ether, and synthetic gaso-

line from methanol. Fuels will be formulated, actual blends will be made, and performance in engines will be evaluated.

27447 (CONF-791082—(Summ.), pp 529-531) **Hydrogen engine data.** Swain, M.R. 1979.

From DOE automotive technology development contractors coordination meeting; Dearborn, MI, USA (23 Oct 1979).

Tests have been performed with the following unthrottled hydrogen engines: with EGR; with H_2O injection; timed injection; improved cooling; increased volumetric efficiency; positive crankcase ventilation; and prechamber. Data on the engines are presented and the performance of the given hydrogen engines is compared with that of equivalent power gasoline engines.

27446 (DOE/CS—0165) **First annual report to Congress on the use of alcohol in motor fuels.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Conservation and Solar Energy). 1 Apr 1980. 62p. NTIS, PC A04/MF A01.

This is the first annual report, submitted to Congress under the provisions of Section 221 of the Energy Tax Act of 1978, PL 95-618, which was signed into law on November 9, 1978. The intent of the Act is clear: to provide a simplified regulatory climate for the production and use of non-fossil alcohol fuels, and to extend to producers and end-users an economic incentive that would increase the rate of penetration of alcohol fuels into the motor-fuel markets. The primary impact of Sec. 221 lies in the exemption of the Federal excise tax on that gasoline and special fuel which contains at least 10% alcohol; including methanol and ethanol not derived from petroleum, natural gas, or coal. This report first describes the technical and regulatory context in which the Act operated during 1979, then presents the specific information required by the Act, namely: (1) a description of the firms engaged in the alcohol fuel industry; (2) the amount of alcohol fuels sold in each State and the amount of gasoline saved in each State by reason of the use of alcohol fuels; (3) the revenue loss resulting from the exemptions from tax for alcohol fuels under sections 4041(k) and 4081(c) of the Internal Revenue Code of 1954; and (4) the cost of production and the retail cost of alcohol fuels as compared to gasoline and special fuels before the imposition of any Federal excise tax. During 1979, a rapid increase in marketing of alcohol fuel, specifically the 10% blend known as gasohol, has caused a significant gap between the motor fuel-marketplace and the information system(s) that compile a consistent data base for domestic energy production and consumption.

MATERIALS

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 26763

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 27478, 27500

27449 (CONF-800581—1) **Longer-term domestic supply problems for nonrenewable materials with special emphasis on energy-related applications.** Goeller, H.E. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 19p. NTIS, PC A02/MF A01.

From Committee on materials (COMAT) meeting; Washington, DC, USA (22 May 1980).

An examination is made on how materials are used in present and future energy production and use. Problem areas which are discussed include by-products production, import limitations, substitution and recycle, accelerated use, synthesis, and the adequacy of the data bases availability. (FS)

27450 (IS-M—274) **A-15 superconducting composites in the 0.1 μm region.** Finnemore, D.K.; Verhoeven, J.D. (Ames Lab., IA (USA)). 1980. Contract W-7405-ENG-82. 16p. (CONF-800816—1). NTIS, PC A02/MF A01.

From International cryogenic materials conference; Madison, WI, USA (21 Aug 1980).

Consumable electrode arc casting procedures have been used to produce 10 kg billets Cu-Nb alloys. The resulting dendrite morphology and homogeneity is suitable for industrial scale production of Nb_3Sn-Cu multifilamentary superconducting wire for magnets in the 8 to 14 Tesla range. If proper heat flow patterns can be maintained, the same techniques should be suitable for 100 kg billets. In the design of these composites for magnet wire, a $Cu_{70}Nb_{30}$ casting is a good choice of Nb content is high J/sub c/ and ease of fabrication are the major considerations. If unusual strain tolerance is the primary consideration, then a lower Nb and lower Sn content is preferred.

27451 **Reignition characteristics of square wave ac manual metal arc welding. Research report 107/1980.** Murch, M.; Lucas, W. Cambridge, England; The Welding Institute (1980). 38p. (NP—24416).

The potential of square wave ac power sources for reducing the open circuit voltage requirements of manual metal arc welding has been investigated for rutile, cellulosic and basic flux-covered electrodes. The characteristic reignition behavior of these electrodes was defined from oscillograms of circuit current and voltage at the instant of arc reignition, for both sine wave and square wave alternating current supplies. When operated at not greater than 80Vrms open circuit, which has been recommended by CENELEC as the maximum permitted no-load voltage on ac equipment, the magnitude and distribution of the reignition voltages and the mean time to reignite the arc, showed quite clearly that the square wave ac waveform facilitated arc reignition. Furthermore, on polarity reversal, the voltage demanded by the arc for reignition through zero was instantaneously available, even at reduced no-load voltage levels, to the extent that basic flux-covered electrodes could be operated at an open circuit as low as 40Vrms without impairing arc stability.

27452 **New technique for preparation of copper single crystals from the bulk using four points.** Otooni, M.A.; McKelvy, M.J. (Arizona State Univ., Tempe). *J. Cryst. Growth;* **4**: 509-511(1978).

A new technique has been developed for preparation of copper single crystals from the bulk without using seeds. In this procedure four tips of a highly recrystallized, polycrystalline, copper rod were used to initiate interfacial growth in four different regions of the melt. During the withdrawal separately formed crystals unite to form a single or a bi-crystal.

27453 **New technique for the preparation of copper single crystals.** Otooni, M.A. (Arizona State Univ., Tempe). *J. Cryst. Growth;* **43**: 391-393(1978).

Application of a new technique has made it possible to prepare single crystals of copper of (100), (110) and (111) orientations. This technique requires thermal cycling of the melt within a few degrees above and below the melting temperature followed by two stages of different cooling rates. No seeding is required. Special design of the reaction vessel minimizes the oxidation. In addition to copper, gold and magnesium single crystals are produced.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 27452, 27478

27454 (HEDL-TME—78-55(Vol.1)) **Computer code for the atomistic simulation of lattice defects and dynamics.** Schiffgens, J.O.; Graves, N.J.; Oster, C.A. (Hanford Engineering Development Lab., Richland, WA (USA); Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract AC14-76FF02170. 22p. NTIS, PC A02/MF A01.

The computer code COMENT used to simulate the effect of temperature, impurities, and pre-existing defects on radiation-induced defect production mechanisms, defect properties, defect migration, and defect stability. This report documents Version IV of COMENT (models, methods, and implementation) and defines current code options. Version IV of COMENT generates only face-centered-cubic (fcc) crystal lattices. However, an effort was made to structure COMENT to allow addition of new options with a minimum of change in the existing version of the code. This document describes the calling program and thirty-two user-defined subroutines. Fourteen subroutines (ALOYORD, DASPKA, DFCT, DSLOAD, DSLOIN, EXPAND, POT1, POT2, POT3, POT4, POT5, POT6, POT7, and THRMAL) are associated with the selection of program options; only a few of these are used in any given analysis. Seven of the other subroutines (CRYSTL, IEAF, INCBOX, LABLE, MINILAT, SPEFORS, and SQUEZ are used to establish a variety of arrays and conditions required for each analysis; most of them are used once in a given calculation. The remaining eleven subroutines (DAMP, DIRECT, IDDEF, NEAF, INBIN, FILBIN, FTBIN, PAC3, UNPAC3, PACF, and UNPACF) are used many times in each calculation; the last eight of these are used many times in each time step during the integration and, therefore, are written in COMPASS (CDC assembly language). The COMPASS subroutines are described in sufficient detail to permit easy conversion to some other assembly language or to FORTRAN.

27455 (LBL—10575) **High resolution studies in martensite.** Sarikaya, M.; Easterling, K.; Thomas, G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Lulea Univ. (Sweden). Dept. of Engineering Materials). Mar 1980. Contract W-7405-ENG-48. 3p. (CONF-800821—2). NTIS, PC A02/MF A01.

From 7. European electron microscopy congress and the international x-ray optics and microanalysis conference; Hague, Netherlands (24 Aug 1980).

Detailed microstructural studies were performed on the lath martensite in steels containing 0.1 and 0.3 wt %-low alloy structural

steels by lattice imaging. This method is providing information on the fine substructural details of dislocated martensite.

27456 (MLM—2630) **Electrical resistivity studies of phase transformations in vanadium hydrogen and deuterium alloys.** Pershing, M.W. (Mound Facility, Miamisburg, OH (USA)). 20 Jun 1980. Contract AC04-76DP00053. 39p. NTIS, PC A03/MF A01.

Phase transitions in vanadium hydrogen and deuterium alloys have been investigated using both electrical resistivity and a differential scanning calorimeter in the temperature range of 85 to 500°K. Alloys studied had compositions ranging from a hydrogen to vanadium ratio of .44 to .82. A computer program was written to calculate the first temperature derivative of the resistivity which resulted in a curve similar to that from the calorimeter. Peaks in the curves were used to define the transition temperatures, which were then compared to results obtained by other researchers. Agreement in the hydride phase boundaries was fairly good except for the β_2-d boundary. All deuteride boundaries were found to be comparable to those reported in the literature. Resistivity variation with hydrogen content was also studied. In the α-phase, parabolic behavior with a maximum near $VH(D)_{.45}$ and an isotopic dependence were observed.

27457 (SAND—80-0431C) **Surface and bulk vibrations in ion-implanted amorphous silica.** Arnold, G.W. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 5p. (CONF-800647—2). NTIS, PC A02/MF A01.

From International conference on the physics of MOS insulators; Raleigh, NC, USA (18 Jun 1980).

Infrared reflection spectroscopy (IRS) has been used to identify the Si-O vibrational mode and confirm previous assignments of Si-OH, and Si-OD vibrational modes in porous amorphous silica implanted with heavy ions and with H^+ and D^+ ions. The Si-O stretching mode ($\sim$ 1015 cm^{-1}) is produced by the damage cascade and is seen in all implanted bulk silicas as well as in porous silica. Implantation of porous silica with H^+ and D^+ ions produces bands at $\sim$ 985 cm^{-1} and $\sim$ 960 cm^{-1}, respectively. The position of all three bands is consistent with O, OH, and OD mass considerations. Implantation of D^+ ions into porous silica containing molecular water and OH^- groups results in D-H exchange. The Si-OH and Si-OD vibrations are also seen in the bulk fused silica at low H/D fluences. These results suggest that intrinsic E'-type defects in bulk silica and dangling Si bonds at internal surface sites.

27458 (UCRL—84368) **Reactions of gold with indium and an indium solder.** Folkers, C.L.; Griffith, C.M.; Siekhaus, W.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Apr 1980. Contract W-7405-ENG-48. 5p. (CONF-800473—1). NTIS, PC A02/MF A01.

From 19. JOWOG-12 meeting; Albuquerque, NM, USA (29 Apr 1979).

Au wires cast in In or solder was studied. Spools containing 0.82, 0.25, and 0.038 mm (0.032, 0.010, and 0.0015 inch) Au wires were cast in In or solder at 185°C for 1 minute. These slugs were treated at 100° or 120°C, and samples sliced off at intervals. We measured the reaction layer thickness in polished samples. Zero time reaction layers due to the casting process were all < 0.1 μm thick. Diamond pyramid hardness values were found for some reaction layers of sufficient size. Selected samples were studied by scanning electron microscope. Phase compositions were determined by microprobe analyses using wavelength dispersive spectroscopy (WDS) or energy dispersive spectroscopy.

27459 **Cyclic grain boundary migration in aluminum during high temperature fatigue.** Yavari, P.; Langdon, T.G. (Univ. of Southern California, Los Angeles). Contract DE-AS03-76SF00113; PA-DE-AT03-76ER10408. *Scr. Metall.;* **14**: No. 5, 551-554(May 1980).

Earlier observations of cyclic grain boundary migration during the reverse bending of Pb at room temperature have been confirmed through similar experiments on Al at 300°C. It is suggested that cyclic grain boundary migration is a general phenomenon of high temperature fatigue, especially at very low frequencies.

27460 **Vacancy loss at grain boundaries in quenched polycrystalline gold.** Siegel, R.W. (Argonne National Lab., IL); Chang, S.M.; Balluffi, R.W. *Acta Metall.;* **28**: No. 3, 249-257(Mar 1980).

Vacancy loss at a variety of grain boundaries in 99.999 wt.% pure polycrystalline gold quenched from 930°C and aged at 60°C was studied by transmission electron microscopy. The vacancy precipitate (stacking-fault tetrahedra) free zones, which formed in the regions adjacent to grain boundaries due to vacancy loss at these sinks during quenching, were analyzed. The vacancy sink efficiency of both small-angle and non-special large-angle grain boundaries was found to be high in the presence of the large chemical potential of the quenched-in vacancies. While there is some evidence that the sink efficiency at small angles is somewhat smaller than at large angles, the results are not inconsistent with a constant vacancy sink efficiency for all of the small-angle and non-special large-angle boundaries observed. On the other hand, the sink efficiency of the special $\Sigma = 3$ coherent twin boundary is significantly lower than for the non-special boundaries. The results are discussed relative to other work in the field, and it is concluded that both small-angle and non-special large-angle boundaries operate as highly effective sinks at high vacancy chemical potentials; and the sink efficiency tends to fall off as the chemical potential decreases or the boundary becomes more special, i.e., more ordered.

27461 **Phase transformations in a uranium + 14 at.% niobium alloy.** Vandermeer, R.A. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Acta Metall.;* **28**: No. 3, 383-393(Mar 1980).

After quenching or quenching and aging, uranium-niobium alloys near the monotectoid composition exhibit a wide range of mechanical properties including the curious shape memory effect (SME). The transformation of the elevated temperature BCC phase during both continuous cooling and isothermal aging was investigated by dilatometry and X-ray diffraction on a 14 at.% alloy. Two transformation stages were detected during rapid cooling from 1075°K to room temperature. The end product was the metastable transition phase, α'', which had a monoclinic unit cell geometry and was thought to transform martensitically according to the reaction sequence γ(bcc) $\rightarrow \gamma^0$(tetragonal) $\rightarrow \alpha''$(monoclinic). For the fastest quenching rate, M/sub S/ was 435°K and M/sub F/ approximately 340°K. The M/sub S/ was found to vary significantly with cooling rate, increasing by 120°K when the cooling rate was reduced from 243°K/s to 2.1°K/s. The reverse transformation temperatures, A/sub S/ and A/sub F/, were heating rate dependent and increased as the rate was decreased. The γ to α'' transition could also be accomplished isothermally by aging at a temperature 165°K above M/sub S/. Indirect evidence was presented to suggest that the supersaturated parent phase may be modified by solute atom precipitation during aging or slow cooling thus promoting the time-dependent transformation to α'' at temperatures above M/sub S/.

27462 **Positron annihilation: a localized probe of lattice defects in metals.** Siegel, R.W. (Argonne National Lab., IL). *Scr. Metall.;* **14**: No. 1, 15-22(1980).

It is evident that positron annihilation spectroscopy has become a valuable technique for the study of metals. Owing to the ability of the positron to localize in a variety of metal defects where its subsequent annihilation yields information regarding its local electronic environment, we now have a new and unique tool available with which to probe the nature of lattice defects in metals, which supplements previously available methods. Many new PAS experimental and theoretical techniques and additional applications to problems concerning defects and microstructures in metals are evolving in this rapidly developing area. It seems clear that in the future, the usefulness of PAS for the study of defects in metals will continue to increase.

27463 **Positron trapping and annihilation at vacancies in bcc refractory metals.** Gupta, R.P.; Siegel, R.W. (Argonne National Lab., IL). *J. Phys., F (London);* **10**: L7-L13(1980).

Theoretical calculations of the positron-vacancy binding energies in the bcc refractory metals Nb, Ta, and W have been carried out using our previously-developed supercell method. The results indicate that the positron is sufficiently tightly bound to the vacancy in these metals that significant thermal detrapping is highly unlikely. Positron annihilation characteristics in the Bloch and vacancy-trapped states of the positron were also calculated for W. The general shapes of the core-electron contributions to the angular correlation curves in the two states were found to be different.

27464 **Phase relations in the uranium-mercury system.** Lee, T.S.; Chiotti, P.; Mason, J.T. (Ames Lab., IA (USA)). *J. Less-Common Met.;* **66**: No. 1, 33-40(Jul 1979).

Published data on the phase boundaries of the uranium-mercury system are inconsistent and incompatible with available thermodynamic data. In an attempt to resolve the observed discrepancies, differential thermal analyses (DTA) of alloys sealed in tantalum capsules were carried out. These data and X-ray and vapor pressure data were used to construct phase diagrams for constrained vapor conditions and for 1 atm pressure. The existence of the three compounds UHg_4, UHg_3 and UHg_2 was confirmed and evidence for an additional compound, UHgsub(x) with x approximately 1.0, is presented. DTA data indicate that this compound decomposes to β-uranium and UHg_2 at 725°C. The compounds UHg_2, UHg_3 and UHg_4 decompose peritectically at 845, 735 and 455°C, respectively. At 845°C and a mercury vapor pressure estimated to be about 90 atm the compound UHg_2 decomposes to γ-uranium and a mercury-rich liquid containing approximately 10 at.% uranium.

27465 **Ordered cobalt-vanadium-iron alloys.** Liu, C.T.; Inouye, H. (to Department of Energy, Washington, DC (USA)). British Patent 2,016,520/A/. 8 Feb 1979. 9p.

Specifications are given of ductile long range ordered alloys with high critical ordering temperature and of the fabrication of wrought articles with these malleable alloys. It is claimed that the maximum combination of high temperature strength, ductility and creep resistance are manifested in the alloy comprising by weight 22-

23% V, 14-20% Fe and the remainder Co and having atomic composition of V(Fe 20-26 Co 74-80)3. The alloy comprising by weight 22-23% V, 16-17% Fe and 60-62% Co has excellent high temperature properties. The alloys are fabricable into wrought articles by casting, deforming, and annealing for sufficient time to provide ordered structure.

27466 Computer simulation of the drift mobility of an ionic impurity in an electric field. Murch, G.E.; Thorn, R.J. (Argonne National Lab., IL). *Philos. Mag., A;* **39**: No. 3, 259-264(1979).

A Monte Carlo method is used to simulate the drift of an ionic impurity in an electric field. Application is made to impurity diffusion via the agency of a vacancy in the face-centered-cubic lattice. The calculation is couched in terms of the five-frequency model of Manning (1964, 1965). The computer simulation results for the drift distance are found to be in excellent agreement with the predictions of the equation derived analytically by Manning.

27467 Structural and magnetic properties of one-dimensional barium vanadium triselenide. Kelber, J. (Argonne National Lab., IL); Reis, A.H. Jr.; Aldred, A.T.; Mueller, M.H.; Massenet, O.; DePasquali, G.; Stucky, G. *J. Solid State Chem.;* **30**: 357-364(1979).

$BaVSe_3$ has been synthesized and its crystal structure determined at 293(2)°K. The structure was solved in the hexagonal space group $P6_3/mmc$(D/sub 6h/⁴), with a = 6.9990(11) and c = 5.8621(13) A. Scans (2Θ) of a polycrystalline sample revealed that $BaVSe_3$ undergoes a transition to an orthorhombic unit cell (b' ≅ 3/ sup 1/2/a, a' ≅ a, c' ≅ c) at 303(5)°K. Magnetic susceptibility measurements between 4 and 300°K indicate that $BaVSe_3$ is paramagnetic down to 41(1)°K, where magnetic ordering occurs, with a magnetic moment in the ordered phase of 0.2 μ/sub B/ per vanadium atom. The orthorhombic lattice distortion may be caused by the freezing in of soft vibrational modes.

27468 Generation of self-consistent Gibbs energy functions for binary systems: the Fe-Cu system as an example. Smith, J.F.; Bailey, D.M. (Iowa State Univ., Ames). *Natl. Bur. Stand. (U.S.), Spec. Publ.;* 1027-1046(10 Jan 1977).

At present a high level of interest exists concerning the prediction of multicomponent phase equilibria by extrapolation of binary Gibbs energy data. The basic problem is the development of good, self-consistent analytical descriptions of the temperature and composition dependences of the Gibbs energies of formation of the phases in the contributory binary systems. The general process for developing such Gibbs energy functions through combination of experimental thermodynamic data with experimental data concerning binary phase equilibria is illustrated by an analysis of a representative binary system, in this case the Fe-Cu system.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 26774, 27235, 27242, 27244, 27606

27469 (COO—2172-27) **Stress relaxation and hillock growth in thin films.** Jackson, M.S.; Li, C.Y. (Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science and Engineering). 1978. Contract EY-76-S-02-2172. 30p. NTIS, PC A03/MF A01.

The relaxation of thermal stress in a thin film adhering to a substrate of differing expansion coefficient is discussed. Good agreement is found between literature data on relaxation during isothermal anneals of Pb films at up to 350°K and model calculations based on a state variable description of plastic flow. The stress system during relaxation is explored, and the absence of diffusional creep is explained. The plasticity-dominated relaxation process suggested by this analysis is shown to be in good qualitative agreement with data on rapid relaxation over the course of a cycle between room and cryogenic temperatures. The implications of this for long-range material transport in the film are discussed. It is shown that hillock volume should increase over the course of a temperature cycle. Finally, a mechanism for hillock nucleation based on grain boundary sliding is suggested.

27470 (DOE/ET/33002—654) **Thermoelectric materials evaluation program spring design to minimize load relaxation.** Grimm, F.R. (Minnesota Mining and Mfg. Co., St. Paul (USA). Industrial Electrical Products Div.). 31 Mar 1980. Contract AC02-76ET33002. 14p. NTIS, PC A02/MF A01.

The recommended spring material for use in thermoelectric modules is either Inconel x or Elgiloy based on their excellent performance and availability. The stress level for generator applications is 75,000 psi. (FS)

27471 (LA-UR—80-1649) **Comparison of flow curves of 6061 aluminum alloy at high and low strain rates.** Carden, A.E.; Williams, P.E.; Karpp, R.R. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 15p. (CONF-800641—5). NTIS, PC A02/MF A01.

From International conference on the metallurgical effects of high strain rate deformation and fabrication; Albuquerque, NM, USA (22 Jun 1980).

Low strain-rate tensile test data (10^{-5} to 10^{-2} s^{-1}) were obtained for 6061 aluminum alloy in the -T6- and -0- condition. Little, if any, strain-rate effect was observed over this range of strain rates. Thirteen expanding ring tests were performed on 1-in.- and 2-in.-diam 6061-T6 and -0- temper rings with maximum strain rates of 3000 to 23,000 s^{-1}. The flow stress at 2% circumferential expansion was determined from all of the tests and is shown to be dependent upon maximum strain rate. Furthermore, a size effect is observed, since flow stress at 2% strain and equal strain rates is greater in 2-in. rings than in 1-in. rings. This size effect may be due to shock hardening, but a definite conclusion has not yet been reached. The -T6- temper rings also show a size effect, but the difference between the 1- and 2-in. rings was not the same for all values of flow stress.

27472 (LA-UR—80-1659) **Plastic deformation of colliding hemishells.** Moir, D.C.; Neal, T.R. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 13p. (CONF-800641—4). NTIS, PC A02/MF A01.

From International conference on the metallurgical effects of high strain rate deformation and fabrication; Albuquerque, NM, USA (22 Jun 1980).

The collision of two hemishells is analyzed where one hemishell is clamped and the other impinges on the inner surface of the clamped hemishell. A model of rigid-perfectly plastic behavior is proposed for the flow of material in the region of contact. An expression relating velocity and deformation is obtained and compared with the results of experiments.

27473 (SAND—79-1891C) **Finite element analysis for the initiation of lamellar tearing in welded joints.** Krieg, R.D.; Thomas, R.K. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 23p. (CONF-800804—10). NTIS, PC A02/MF A01.

From ASME century 2 emerging technology conference; San Francisco, CA, USA (10 Aug 1980).

A numerical procedure using the finite element method is presented for predicting the initiation of lamellar tearing in fillet welded T-joints commonly employed in large structures. Starting with a prescribed geometry, the welding process is approximated by a known time-dependent volumetric heat source which simulates the arc heating and deposition of liquid metal. The transient nonlinear thermal and stress problems are then solved using finite element computer codes. Results of the elastic-plastic stress analysis are presented showing a predicted region of incipient lamellar tearing based on a ductile fracture theory which qualitatively agrees with the size and location of tears typically observed in photomicrographs. Additional insight into post failure crack length and stability is presented based on a simplified linear elastic fracture mechanics approach. Although the analysis procedure shows signs of promise, several weak points in the model are pointed out which must be improved before lamellar tearing can be quantified in an approach of this general type.

27474 (SAND—79-2126) **Consistent stress-strain ductile fracture model as applied to two grades of beryllium.** Priddy, T.G.; Benzley, S.E.; Ford, L.M. (Sandia Labs., Albuquerque, NM (USA)). Jan 1980. Contract AC04-76DP00789. 46p. NTIS, PC A03/MF A01.

Published yield and ultimate biaxial stress and strain data for two grades of beryllium are correlated with a more complete method of characterizing macroscopic strain at fracture initiation in ductile materials. Results are compared with those obtained from an exponential, mean stress dependent, model. Simple statistical methods are employed to illustrate the degree of correlation for each method with the experimental data.

27475 (SAND—80-1325C) **Application of survival statistics to the impulsive fragmentation of ductile rings.** Grady, D.E. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 12p. (CONF-800641—3). NTIS, PC A02/MF A01.

From International conference on the metallurgical effects of high strain rate deformation and fabrication; Albuquerque, NM, USA (22 Jun 1980).

The current study addressed the problem of predicting fragment size distributions resulting from the tensile fracture of impulsive loaded bodies. Theory was restricted to one-dimensional bodies subjected to uniform loading. A rigorous treatment of the statistics of dynamic fragmentation has been attempted using concepts of survival statistics and incorporated here through the relation derived by Johnson and Mehl and Avrami. Physical concepts are introduced through the assumption of a uniform nucleation rate of fracture and the propagation of stress-relief waves governed by the tensile response of an ideally ductile material. An analytic distribution curve was derived for ductile fracture and compared with the fragmentation data of Wesenberg and Sagartz on aluminum rings. The analytic expression was found to provide a good representation of the data although further experimental work in this area is strongly needed.

The present analysis and resulting fragment size distribution expressions are fairly complex even for the very simple geometry and loading conditions considered. Direct application of the method to more complicated fragmentation events would probably be difficult. Perhaps the greatest value of the present type of analysis will be the insight that it provides on the statistical nature of impulse fragmentation - hopefully a source of fresh ideas for computational models currently under development.

27476 (UCRL—83987) **Rate dependent inelastic behavior of polycrystalline solids using a dislocation model.** Werne, R.W.; Kelly, J.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.; California Univ., Berkeley (USA)). 26 Feb 1980. Contract W-7405-ENG-48. 9p. (CONF-800804—14). NTIS, PC A02/MF A01.

From ASME century 2 emerging technology conference; San Francisco, CA, USA (10 Aug 1980).

A rate dependent theory of polycrystalline plasticity is presented in which the solid is modeled as an isotropic continuum with internal variables. The rate of plastic deformation is shown to be a function of the deviatoric portion of the Cauchy stress tensor as well as two scalar internal variables. The scalar internal variables, which are the dislocation density and mobile fraction, are governed by rate equations which reflect the evolution of microstructural processes. The model has been incorporated into a two dimensional finite element code and several example multidimensional problems are presented which exhibit the rate dependence of the material model.

27477 Plastic instabilities and uniaxial tensile ductilities. Nichols, F.A. (Argonne National Lab., IL). *Acta Metall.;* **28**: No. 6, 663-673(Jun 1980).

Since Hart published his theory of the tensile test, there has been much activity in analyzing unaxial tensile instabilities and in relating them to observed fracture strains, especially as affected by strain-rate sensitivity. Some progress has been made. However, considerable confusion exists as well, especially concerning the predictions of Hart's theory with regard to fracture strains as affected by strain-rate sensitivity. We present a unified survey, considering both geometric and pre-straining types of necks, and including both the onset of instability and the rate of propagation of instabilities. It will be shown that most of the results of the more recent analyses are already implicitly contained (though with somewhat less rigor) in Hart's theory, although this author has been either misinterpreted or totally overlooked in some of the more recent treatments. Comparisons will be presented between analytical predictions and experimentally observed, uniaxial fracture strains.

27478 Weldability and hot cracking in thorium-doped iridium alloys. David, S.A.; Liu, C.T. (Oak Ridge National Lab., TN). *Met. Technol.;* 102-106(Mar 1980).

Modified iridium alloys containing ≧ 100 ppM Th were found to be very susceptible to cracking during gas tungsten-arc and electron-beam welding. However, the electron-beam welding process showed greater promise of success in welding these alloys, in particular Ir-0.3 W doped with 200 ppM Th and 50 ppM al. The weldability of this particular alloy was extremely sensitive to the welding parameters, such as beam-focus condition and welding speed, and the resulting fusion-zone structure. At low speeds successful electron-beam welds were made over a narrow range of beam-focus conditions. However, at high speeds successful welds can be made over an extended range of focus conditions. The fusion-zone grain structure is also a strong function of welding speed and focus condition. Weld-metal cracking was found to be caused by the combined effects of heat-affected-zone liquation cracking and solidification cracking. Scanning electron microscopic analysis of the fractured surface revealed patches of low-melting eutectic. Also, in the welds that cracked, a region of positive segregation of thorium was identified near the fusion boundary. This highly thorium-segregated region may also act as a source for the nucleation of a liquation crack.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 27298, 27456, 27462, 27467, 27468, 27473, 28138, 28139, 28140, 28141, 28142

27479 Photoelectron spectroscopy in the energy region 30 to 800 eV using synchrotron radiation. Lindau, I.; Spicer, W.E. (Stanford Univ., CA (USA). Stanford Synchrotron Radiation Lab.). *J. Electron Spectrosc. Relat. Phenom.;* **15**: 295-306(Jan 1979).

From Australian conference on electron spectroscopy; Melbourne, Australia (22 - 25 Aug 1978).

With the advent of synchrotron radiation, the photoemission techniques were extended to a continous range of excitation energies in the far ultraviolet and soft X-ray regions, adding tremendously to the usefulness of photoemission as a probe of the electronic structure of materials. In this paper, the application of photoelectron spectroscopy using synchrotron radiation to the studies of oxygen chemisorption/oxidation of Si surfaces, metal overlayers on III-V semiconductor surfaces, chemisorption on transition metal surfaces, and the surface electronic structure of CuNi alloys is discussed.

27480 Deep deuterium traps in Y-implanted Fe. Myers, S.M.; Picraux, S.T.; Stoltz, R.E. (Sandia Laboratories, Albuquerque, New Mexico 87185). DE-AC04-76-DP00789. *Appl. Phys. Lett.;* **37**: No. 2, 168-170(15 Jul 1980).

Ion-implanted Y in Fe is shown to trap deuterium with an enthalpy of ≃1.3 eV. This binding is the strongest yet reported for a hydrogen isotope in an Fe-based alloy. The trapping is attributed to a Y-vacancy complex, with the coupling being augmented by a Y-hydrogen chemical interaction.

27481 Work function of carburized rhenium. Pallmer, P.G. Jr.; Gordon, R.L.; Dresser, M.J. (Pacific Northwest Laboratory, Richland, Washington 99352). EY-76-C-06-1830. *J. Appl. Phys.;* **51**: No. 7, 3776-3779(Jul 1980).

Variations of the electronic work function of carburized rhenium foils containing approximately 5 at.% carbon have been observed using the contact potential difference technique. Surface work function was observed to vary between 5.25 and 4.1 eV, with the work function of pure rhenium taken as 5.0 eV. Decrease in work function has been ascribed to the formation of graphitic layers on the surface at temperatures below the temperature of saturated solubility. The high work function surface was observed with all carbon in solution and has been ascribed to the presence of amorphous carbon near the surface.

27482 Slow position studies on clean and oxygen-exposed Sn(100) surfaces. Jean, Y.C.; Lynn, K.G.; Carroll, M. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B: Condens. Matter;* **21**: No. 11, 4935-4938(1 Jun 1980).

A well-characterized Sn(100) sample was examined with monoenergetic positrons before and after exposure to oxygen. The positronium formation at the surface was measured as a function of sample temperature, incident positron energy, and oxygen exposure. The positronium fraction increased both with sample temperature and oxygen exposure, but decreased with increasing incident positron energy. Positronium formation from thermally activated detrapping of the positron from the surface state is observed providing an estimate of the positron binding energy to this surface state. No change was found in the positronium fraction when the Sn(100) crystal was exposed to hydrogen suggesting a lack of interaction between hydrogen and Sn. In all of the above cases positronium was emitted but no positron re-emission was observed; this result suggests a negative positronium work function but a positive positron work function.

27483 Determination of the third-order nonlinear optical coefficients of germanium through ellipse rotation. Watkins, D.E.; Phipps, C.R. Jr.; Thomas, S.J. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Opt. Lett.;* **6**: No. 6, 248-249(Jun 1980).

We describe the first reported direct determination of the 10-μm nonlinear susceptibility in intrinsic Ge through time-resolved ellipse rotation. We found that $X_3^{1111} = 2.5 \times 10^{-11}$ esu and $X_3^{1221} = 1.3 \times 10^{-11}$ esu, significantly below previous estimates.

27484 Ettingshausen-Nernst coefficient and transport properties of alumel from 200 to 473°K. Moore, J.P.; Graves, R.S. (Oak Ridge National Lab., TN). *J. Phys. Chem. Solids;* **41**: 129-133(1980).

The adiabatic Ettingshausen-Nernst coefficient. Q/sub a/, and the Righi-Leduc coefficient, R/sub a/, have been measured on Alumel and Nickel. The results show that Q/sub a/ of alumel increases with temperature and has a precipitous drop near its ferromagnetic-paramagnetic transition temperature (T/sub c/ =425.6°K). The experimental Q/sub a/ relates well with temperature measurements errors experienced using Chromel-P vs Alumel thermocouples in crossed thermal and magnetic fields.

27485 Thermodynamic properties of the mercury-uranium system. Chiotti, P.; Mason, J.T.; Lee, T.S. (Ames Lab., IA (USA)). *J. Less-Common Met.;* **66**: No. 1, 41-50(Jul 1979).

The mercury vapor pressure and e.m.f. data obtained in this investigation were combined with literature data to arrive at a consistent set of thermodynamic quantities for the mercury-uranium system. At 725°C (998°K) the compound UHg/sub x/ (x approximately 1.0) decomposes to UHg_2 and β-uranium DTA data were employed to estimate the heat of reaction and to derive the free energy of formation of this compound. Relations for the relative partial molar quantities for mercury and uranium in the various two-phase regions are derived. These data are reasonably consistent with the revised phase diagram.

27486 Solubility of tritium in yttrium at temperatures from 250 to 400 °C. Clinton, S.D.; Watson, J.S. (Oak Ridge National Lab., TN (USA)). *J. Less-Common Met.;* **66**: No. 1, 51-57(Jul 1979).

The solubility of tritium in yttrium was measured at temperatures from 250 to 400°C and at low pressures (atomic fractions of tritium in yttrium below 0.001). In this region the solubility followed

the Sieverts' relationship and the Sieverts' constant was Ksub(Y-T) (ppm Torrsup(-1/2)) = 0.55 exp (22 900/RT). The results agree with extrapolations of previous data and indicate that sorption of tritium by yttrium is a promising technique for recovering tritium from the molten lithium blankets proposed for fusion reactors.

27487 Diffusion and electrotransport of iron, cobalt and nickel in thorium metal. Weins, W.N.; Carlson, O.N. (Ames Lab., IA (USA)). *J. Less-Common Met.;* **66**: No. 1, 99-110(Jul 1979).

The diffusion and electrotransport parameters for iron, cobalt and nickel were measured in α (f.c.c.) and β (b.c.c.) thorium over the temperature range 965 - 1625°C. All three solutes have negative Z^* values corresponding to migration toward the anode and a marked temperature dependence of Z^* in both phases. From a least-squares treatment of the diffusivity data, values of D_0 and Q in the equation $D = D_0 \exp(-Q/RT)$ were obtained for each solute. The D_0 and Q values are more characteristic of interstitial solute behaviour than of substitutional solutes, as are the electromigration velocities for the temperature range investigated. These results indicate that iron, cobalt and nickel are fast diffusing solutes in thorium metal.

27488 Terminal solubility of hydrogen in Nb-Ta alloys and characterization of the solid solutions. Westlake, D.G.; Miller, J.F. (Argonne National Lab., IL (USA)). *J. Less-Common Met.;* **65**: No. 1, 139-154(May 1979).

Solvus temperatures for 2, 5 and 12 at.% H were determined resistometrically in tantalum, niobium and nine Nb-Ta alloys. The terminal solubility of hydrogen in the alloys reached a maximum for Nbsub(0.3)Tasub(0.7). For example, at 250 K the solvus for this pseudobinary metal-metal hydride system lies at 12 at.% H compared with 1.5 for Nb and 6 for Ta. Pressure-composition-temperature measurements were made on the Nbsub(0.3)Tasub(0.7)-H solid solutions, but the resulting thermodynamic data exhibited no anomalous behaviour. The effects of hydrogen on lattice parameters and resistivities were also determined for these systems. The apparent terminal solubilities are discussed in terms of these observations and in terms of metal atom size effects, electronic structure and the properties of the hydride phase.

27489 Electronic structure of Sm surface studied by synchrotron-radiation-excited-photoelectron spectroscopies. Allen, J.W.; Bauer, R.S.; Gustafsson, T.; Hagstrom, S.B.M. (Xerox Palo Alto Research Center, CA (USA)); Johansson, L.I.; Lindau, I. (Stanford Univ., CA (USA). Stanford Synchrotron Radiation Lab.). *J. Phys. (Paris), Colloq.;* No. 5, C5.346-C5.347(1979).

From International colloquium on physics of metallic rare earths; Saint-Pierre-de-Chartreuse, France (4 - 7 Sep 1978).

We have utilized synchrotron radiation in the 50-250 eV range to make surface sensitive photoelectron measurements on Sm. For 150 eV photons the valence band photoelectron energy distribution shows both $4f^5$ and $4f^6$ structure. By constant initial state photoelectron yield spectroscopy we have measured separately the $4d \rightarrow 4f$ photon absorption of $4f^5$ and $4f^6$ surface Sm atoms.

27490 Low temperature heat capacity studies on intermetallic and semimetallic rare earth compounds. Gschneidner, K.A. Jr.; Takeshita, T.; Beaudry, B.J.; McMasters, O.D. (Ames Lab., IA (USA)); Taher, S.M.A. (Ames Lab., IA (USA); Wichita State Univ., KS . *J. Phys. (Paris), Colloq.;* No. 5, C5.114-C5.115(1979).

From International colloquium on physics of metallic rare earths; Saint-Pierre-de-Chartreuse, France (4 - 7 Sep 1978).

The results of low temperature (1-20°K) heat capacity measurements on some RM_5 phases, which are good hydrogen absorbers, and on some La_3S_4-La_2S_3 compounds are reported and discussed. Also included are some measurements on the superconducting LaSsub(1.33)-LaSsub(1.40) phases.

27491 High field de Haas-van Alphen spectroscopy in transition metals. Crabtree, G.W. (Argonne National Lab., IL); Dye, D.H.; Karim, D.P.; Ketterson, J.B. *J. Magn. Magn. Mater.;* **11**: 236-246(1979).

Detailed studies are reported of the electronic properties of the high T/sub c/ superconductor niobium and the Stoner enhanced paramagnets platinum and palladium. Parametrization schemes based on the KKR method of band calculation are shown to give excellent representations of the Fermi surface properties. Agreement of the experimental Fermi radii with those of first principles band theory is very good. Local values of the many body enhancements due to electron-phonon and electron-electron interaction are derived by comparison of experimental and theoretical Fermi velocities.

27492 Analysis of LO and TO phonon assisted free exciton luminescence in silicon. Hammond, R.B.; Silver, R.N. (Los Alamos Scientific Lab., NM). *Solid State Commun.;* **28**: 993-996(1978).

Linefits are made of LO and TO phonon assisted free excition luminescence spectra in silicon. The temperature range covered is 1.55-4.0°K. Values of the recombination rates, the phonon energy splitting, the intrinsic line broadening, and the exciton ground state splitting are deduced. The splitting of the indirect ground state is found to be 0.31 +- 0.03 meV.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 26772, 26775, 26778, 26801, 27050, 27051, 27052, 27132, 27141, 27235, 27240, 27241, 27243, 27244, 27360, 27482

27493 STEM examination of the localized corrosion behavior of a duplex stainless steel. Manning, P.E.; Lyman, C.E.; Duquette, D.J. (Rensselaer Polytechnic Inst., Troy, NY). *Corrosion;* **36**: No. 5, 246-251(May 1980).

The most susceptible site for pit initiation was found by optical metallography and transmission electron microscopy to be the retained delta ferrite/austenite interface. Microanalysis results, which were obtained with scanning transmission electron microscopy, virtually disprove the chromium depletion theory for pit initiation at these interfaces. The most likely explanation is a segregation of impurities such as sulfur or phosphorus to the interface during the nonequilibrium solidification process associated with weldments. The passive film over the delta ferrite/austenite interface as well as the repassivation kinetics of this interface are degraded by the presence of the impurities and are therefore the most susceptible sites for pit initiation and growth.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 27241

27494 (HEDL-TME—78-55(Vol.2)) Computer code for the atomistic simulation of lattice defects and dynamics. Schiffgens, J.O.; Graves, N.J.; Oster, C.A. (Hanford Engineering Development Lab., Richland, WA (USA); Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract AC14-76FF02170. 182p. NTIS, PC A09/MF A01.

This report documents Version IV of COMENT and defines current code options. An effort was made to structure COMENT to allow for additional options with a minimum of change in the existing version of the code. Although COMENT was specifically written in FORTRAN IV and COMPASS (CDC assembly language) to take full advantage of CDC 6000/7000 series computer characeristics, it can with relatively little effort be adapted to other computer sysems. This report is intended to present sufficient detailed information about the code to permit the ready addition and/or alteration of subprograms to satisfy particular needs.

27495 Comparison of initial damage rates due to electron and neutron irradiations measured by internal friction techniques. I. Flux and temperature dependencies; scaling law. Goldstone, J.A.; Parkin, D.M.; Simpson, H.M. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). W-74-05-ENG.36. *J. Appl. Phys.;* **51**: No. 7, 3684-3689(Jul 1980).

The initial pinning rate of dislocations, as computed from changes in Young's modulus, was measured in high-purity polycrystalline copper during electron and neutron irradiations. For the same sample, flux and temperature dependencies of the pinning rate were studied for irradiations by 14.1-MeV neutrons and 1.0- and 0.5-MeV electrons. For a temperature of 330 K, the initial pinning rate depended on the flux to the 0.89 +- 0.2 power in contradiction of simple kinetics. Additionally, to duplicate a given pinning rate due to a 14.1-MeV neutron flux between 10^{11} and 10^{12} m^{-2} s^{-1}, a 0.5-MeV electron flux of 21.7 +- 0.7 or a 1-MeV electron flux of 2.2 +- 0.1 times the neutron flux was necessary. Temperature dependence studies from 310 to 390 K showed the same dependence for neutron and electron irradiations. The difference in migration energies in the lattice and along the dislocations was found to be 0.18 +- 0.02 eV over this temperature range. The copper sample exhibited the Simpson-Sosin peaking of the decrement during all irradiations. The above observations lead us to conclude that the same defect, the interstitial, is responsible for pinning during both electron and neutron irradiation.

27496 Comparison of initial damage rates due to electron and neutron irradiations measured by internal friction techniques. II. Neutron energy dependence. Goldstone, J.A.; Parkin, D.M.; Simpson, H.M. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). W-7405-ENG.36. *J. Appl. Phys.;* **51**: No. 7, 3690-3696(Jul 1980).

Neutron energy dependence of the initial dislocation pinning rate was studied from 1.9 to 23.4 MeV on a copper sample. By comparing initial pinning rates from 0.5- and 1.0-MeV electron irradiations and the neutron irradiations, and using the defect production rate for electron bombardments, an estimate of the free interstitial production cross sections (FIPCS) for neutrons was made. These FIPCS values are compared with several theories which predict the total number of Frenkel pairs produced as a function of recoil energy. Comparison with the simplest of these models (Nor-

gett-Robinson-Torrens) showed good agreement with the trend of the energy dependence of the FIPCS. Additional comparison showed that only 1% or less of the predicted number of interstitials survive as free interstitials. A gold sample was also studied and results of 2-MeV electron and 14.3-MeV neutron irradiations are also presented.

27497 Transmission electron microscope investigations of defects produced by individual displacement cascades in Si and Ge. Ruault, M.O.; Jaeger, W. (Argonne National Lab., IL (USA)). *J. Microsc. (Oxford);* **118**: No. , 67-73(Jan 1980).

From Microscopy of semiconducting materials; Oxford, UK (9 - 11 Apr 1979).

Monocrystalline brace 111 brace Si and Ge specimens have been irradiated with atomic and molecular heavy ions in order to study the influence of the cascade energy density and the interaction between displacement cascades on the defect production. Transmission electron microscope (TEM) studies were performed to investigate the defect parameters. After atomic irradiation of Si and Ge the defects analysed (typical size 3 to 5 nm) are of interstitial type. Both defects with three-dimensional strain centres and defects with a strongly asymmetric strain field were observed. An analysis of the yield and the defect size in Si as a function of ion dose suggests that the defects are formed within individual cascades rather than by a process involving overlapping cascades. Changes of the energy density locally deposited in the lattice do not affect yield and size significantly. Under otherwise similar experimental conditions, the average defect depth is significantly larger for Bi_2^+ irradiations than for Bi^+ irradiations.

27498 Austenitic stainless steel alloys having improved resistance to fast neutron-induced swelling. (to Department of Energy, Washington, DC (USA)). British Patent 1,555,778/A/. 28 Jun 1976. 10p.

A specification is provided for an austenitic stainless steel consisting of Fe, Cr and Ni, with small amounts of Mo, Mn, Si and Ti. The specification includes a fuel element and a method for cladding a reactor fuel. .

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 26782, 26965, 27400, 27401, 27406

PREPARATION AND FABRICATION

27499 (SAND—79-1405C) **Glasses and glass ceramics for sealing to aluminum alloys.** Wilder, J.A. Jr. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 6p. (CONF-800705—2). NTIS, PC A02/MF A01.

From 12. international glass congress; Albuquerque, NM, USA (6 Jul 1980).

Alkali alkaline earth phosphate glasses which hermetically seal to aluminum alloys were developed. They have coefficients of thermal expansion greater than 200 x 10^{-7} $°C^{-1}$ and glass transition temperatures below 400°C. The relatively low fracture toughness values (K/sub IC/) of the glasses, 0.43 to 0.53 MPa(m/sup 1/2/), (K/sub IC/ of silica = 0.7 MPa m/sup 1/2/) increase by approximately 25% when the glasses are converted into glass ceramics. Depending upon parent glass compositions and heat treatment, crystal phases of sodium metaphosphate, sodium trimetaphosphate, sodium barium phosphate, or sodium calcium pl..sphate may develop. DC electrical resistivities of the glasses are 10^8 to 10^{10} ohm-cm at 230°C.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 27457, 27507

27500 (BMFT-FB-T—79-124) **Joining of silicon nitrides and silicon carbides to refractory metals.** Mueller-Zell, A.; Hennicke, H.W. (Bundesministerium fuer Forschung und Technologie, Bonn-Bad Godesberg (Germany, F.R.)). 1979. 62p. (In German). NTIS (US Sales Only), PC A04/MF A01.

The report is part of the project Ceramic Materials for Automobile Gas Turbines which has been sponsored by the Ministry of Research and Technology of the Federal Republic of Germany since 1974. Great efforts have been made to get knowledge of joining special ceramics to refractory metallic components and to describe appearance and manner of the bonding. Laminated materials are important for the Gas Turbine project either with regard to the bonding of a ceramic disk with a metallic axle or of blades of ceramic and a disk of alloy. Adhesive material joints made from ceramic (Si_3N_4, SiC) and refractory metals (Mo, W, Co, Cr, Ni) are manufactured by high vacuum solid state bonding. Several methods of setting up positive couplings are described. Methods to examine nature and strength of the bonding are mentioned. The results show a successful continuation of the project.

27501 Phase equilibria in the samarium-oxygen-carbon system. The existence of trisamarium monocarbide. Haschke, J.M.; Deline, T.A. (Rockwell International, Golden, CO). *Inorg. Chem.;* **19**: No. 2, 527-532(Feb 1980).

Composition and vaporization studies in the temperature range 1400 to 2200 K show that four condensed phases exist in the binary and ternary regions of the Sm-O-C system. A CaC_2-type dicarbide, a nonstoichiometric Pu_2C_3-type phase between $SmC_{1.36}$ and $SmC_{1.45}$, and a stoichiometric NaCl-type oxide carbide near the $SmO_{0.5}C_{0.4}$ and Sm_2O_3 are observed. The Pu_2C_3-type carbide, SmC/sub y/, vaporizes to form Sm(g) and SmC_2(s), which in turn vaporizes to Sm(g) + C(s). The vaporization products of the oxide carbide are SM(g) + SmC/sub y/(s) + Sm_2O_3(s). The cubic lattice parameter and the carbon content of SmC/sub y/ decrease with increasing equilibration temperature. Hydrolysis data for SmC/sub y/ indicate that its carbide species are a mixture of diatomic (acetylide) and monoatomic (methanide) ions; its nonstoichiometric behavior is consistent with a mechanism of anion altervalence based on an acetylide-methanide equilibrium process. $SmO_{0.5}C_{0.4}$ is best described as an oxide methanide containing randomly distributed anion vacancies. The present results fail to confirm the existence of a metal-rich carbide near the Sm_3C composition and suggest that the phase observed in an earlier study was actually the oxide carbide. 3 figures, 3 tables.

27502 Characterization of metastable tetragonal hafnia. Hunter, O. Jr. (Ames Lab., IA (USA)); Scheidecker, R.W.; Tojo, S. *Ceramurgia Int.;* **5**: No. 4, 137-142(Oct-Dec 1979).

Conditions for retaining metastable tetragonal HfO_2 at room temperature were determined. Mechanical properties were measured as a function both of the fraction of retained metastable HfO_2 and of the porosity. The metastable phase was retained by 1) thermal decomposition of pure $Hf(OH)_4$ or $HfOCl_2$ and 2) hot pressing of HfO_2 + 1% Er_2O_3. The critical size for retaining pure tetragonal HfO_2 at room temperature in a stress free condition is 100 A, whereas the critical size for the 1% Er_2O_3 hot pressed composition is significantly larger. The elastic moduli were found to vary linearly with porosity and showed a small effect due to the metastable phase presence.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 26779, 27502

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 27501

27503 (MLM—2733(OP)) **Role of Al substitution on hydrogen diffusion in β-LaNi$_5$Al/sub y/H/sub x/.** Bowman, R.C. Jr.; Craft, B.D.; Attalla, A.; Mendelsohn, M.H.; Gruen, D.M. (Mound Facility, Miamisburg, OH (USA); Argonne National Lab., IL (USA)). 1980. Contract AC04-76DP00053. 13p. (CONF-800402—14). NTIS, PC A02/MF A01.

From International symposium on the properties and applications of metal hydrides; Colorado Springs, CO, USA (7 Apr 1980).

Proton relaxation times measured by NMR pulse techniques were used to investigate hydrogen diffusion behavior in β-LaNi/sub 5-y/Al/sub y/H/sub x/ for $0 < y < 1.5$. Al substitution increases E/sub a/ with a subsequent reduction in the apparent diffusion constants by more than two orders of magnitude relative to β-$LaNi_5H_6$ when $y \geq 1$. T_1 and T_1/sub rho/ values from high purity samples suggest that two types of jump processes with different activation energies are probably involved.

27504 Photosensitivity enhancement by H- and He-ion implantation in lead lanthanum zirconate titanate ceramics. Land, C.E.; Peercy, P.S. (Sandia Laboratories, Albuquerque, New Mexico 87185). DE-AC04-76-DP00789. *Appl. Phys. Lett.;* **37**: No. 1, 39-41(1 Jul 1980).

H- and He-ion implantation has been used to increase the photoferroelectric image storage sensitivity of lead lanthanum zirconium titanate ceramics by factors of ~10 and ~30, respectively. The increased photosensitivity can be attributed primarily to implantation-produced disorder, which increases the efficiency of carrier photoexcitation and trapping and reduces the exposure energy required to establish nonvolatile space-charge fields. Implantation-induced disorder may also contribute to a substantial increase in photoconductivity in the ion-damaged near-surface region.

27505 Enhancement of electrical conductivity in MgO due to lithium impurities. Chen, Y. (Oak Ridge National Lab., TN); Kernohan, R.H.; Boldu, J.L.; Abraham, M.M.; Eisenberg, D.J. Crawford, J.H. Jr. *Solid State Commun.;* **33**: 441-443(1980).

The electrical conductivity of lithium-doped MgO crystals at room temperature is shown to be enhanced by the thermal creation of stable $(Li)^0$ defects by oxidation at elevated temperatures. The current-voltage curves are found to be nonlinear at low voltages.

The enhancement in conductivity is attributed to localized regions of high $(Li)^0$ concentration in which the holes at the $(Li)^0$ sites are thermally ionized into the valence band, causing these regions to be semiconducting.

27506 X-ray photoelectron spectroscopy (XPS) studies of clean and hydrated TiO_2 (rutile) surfaces. Sham, T.K. (Brookhaven National Lab., Upton, NY); Lazarus, M.S. *Chem. Phys. Lett.;* **68**: No. 2,3, 426-432(15 Dec 1979).

Some preliminary but very interesting XPS observations of TiO_2 (rutile) surfaces under various conditions without going into quantitative details of surface structures are presented. Ambient TiO_2 samples are always covered with chemisorbed and physisorbed moisture. The O 1s binding energies for the surfaces site are always shifted to the higher binding energy whereas the opposite is true for the Ti sites. Results agree with the view that TiO_2 surface is stabilized by chemisorption of H_2O under ambient conditions and that the surface sites Ti-OH and OH(s) have different acidity. Adsorption of NH_3 confirms the presence of acidic OH(s) sites on hydrated TiO_2 surfaces. The O 1s and Ti 2p spectra for clean TiO_2 surfaces show that oxygen ions terminate at the surfaces, whereas Ti^{4+} ions are somewhat screened under the surface oxygens. The O 1s and Ti 2p binding energies indicate that the formation of .OH radicals which are important in TiO_2 surface photocatalytic behavior (oxidation of OH^- by the holes created by photons) are probably easily formed from the singly bonded Ti-OH groups. XPS should be very valuable to studies of surface electronic properties controlled by additives.

27507 Physical properties of $BeAl_2O_4$ single crystals. Cline, C.F. (Univ. of California, Livermore); Morris, R.C.; Dutoit, M.; Harget, P.J. *J. Mater. Sci.;* **14**: 941-944(1979).

Physical properties of Czochralski-grown single crystal $BeAl_2O_4$ are reported. Data on hardness, thermal expansion, thermal conductivity, and elastic constants are tabulated as a function of crystallographic orientation. Results indicate that the properties of $BeAl_2O_4$ compare favourably with those of Al_2O_3.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 26779

27508 (LBL—10607) Adherence of Al_2O_3 to CoCrAl coatings. Whittle, D.P.; Boone, D.H.; Allam, I.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 17p. (CONF-800439—4). NTIS, PC A02/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (21 Apr 1980).

Adhesion between surface scale and protective coating is an essential requirement of a material possessing good overall oxidation resistance. Poor adhesion can lead to exfoliation of the oxide in response to thermal cycling, or mechanically applied stresses, resulting in enhanced oxidation rates. Marked improvements in scale/substrate adhesion can be obtained via the formation of protrusions of oxide growing into the substrate. These act to key the protective scale to the surface and are more effective when a uniform distribution of small oxide pegs can be achieved. Thus, the structure of the coating, the type of rare earth addition, and its concentration are all important and this has been examined using EB-PVD CoCrAl coatings containing a variety of elemental additions. These have been subjected to both isothermal and cyclic oxidation in the temperature range 1000 to 1200°C. The coating/scale interface and the development of pegs growing into the coating has been examined in detail by dissolving away the underlying metal + coating using a Br-methanol.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 27609, 27612

COMPOSITE MATERIALS

PREPARATION AND FABRICATION

27509 (UCRL—15019) Low-temperature: fast setting cements. Boyer, J.P.; Snyder, M.J. (Battelle Columbus Labs., OH (USA)). 10 Apr 1979. Contract W-7405-ENG-48. 38p. NTIS, PC A03/MF A01.

It was not possible to identify a cementitious material which could readily perform under all of the required conditions. Three potential mixtures were identified. Although these mixtures do not perform adequately at all temperatures with respect to either viscosity or setting time it is believed that further in-depth study could result in modifications to the reactions or engineering solutions to mixing and placing and permit the development of a cement system meeting all of the criteria. The three systems which we believe should be investigated further are: (1) zinc oxide/zinc chloride/aqueous ethylene glycol solution; (2) calcium oxide/glycerin; and (3) cuprous oxide/difluorophosphoric acid.

MECHANICAL PROPERTIES

27510 Solutions for effective shear properties in three phase sphere and cylinder models. Christensen, R.M. (Univ. of California, Livermore); Lo, K.H. Contract W-7405-ENG-48. *J. Mech. Phys. Solids;* **27**: 315-330(1979).

Solutions are presented for the effective shear modulus of two types of composite material models. The first type is that of a macroscopically isotropic composite medium containing spherical inclusions. The corresponding model employed is that involving three phases: the spherical inclusion, a spherical annulus of matrix material and an outer region of equivalent homogeneous material of unlimited extent. The corresponding two-dimensional, polar model is used to represent a transversely isotropic, fiber reinforced medium. In the latter case only the transverse effective shear modulus is obtained. The relative volumes of the inclusion phase to the matrix annulus phase in the three phase models are taken to be the given volume fractions of the inclusion phases in the composite materials at large. The results are found to differ from those of the well-known Kerner and Hermans formulae for the same models. The latter works are now understood to violate a continuity condition at the matrix to equivalent homogeneous medium interface. The present results are compared extensively with results from other related models. Conditions of linear elasticity are assumed.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 27082

RADIATION EFFECTS

27511 Comparison of transmission electron microscopy and channeled Rutherford backscattering techniques to evaluate the multilayer subsurface damage structures. Sadana, D.K.; Strathman, M.; Washburn, J.; Booker, G.R. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). N/A. *Appl. Phys. Lett.;* **37**: No. 2, 234-236(15 Jul 1980).

Cross-sectional transmission electron microscopy (TEM) and MeV He^+ channeling methods have been used to examine different damage structures present under the color bands visible at the surface of a high-dose-rate P^+ -implanted (111) Si wafer implanted to a dose of 7.5×10^{15} ions/cm^2. TEM and channeling results obtained from individual colored regions showed a good qualitative correlation in that discrete damage layers observed in the cross-sectional TEM micrographs appeared as discrete peaks in the channeled spectra. The mean depths of the damage layers obtained from these two methods were in agreement. However, the widths of the deeper-lying damage layers calculated from the channeling measurements were always greater than the widths observed by TEM. An empirical method based on subtraction of dechanneling background in the channeling spectra gave damage layer widths that were in close agreement with the TEM results.

POLYMERS AND PLASTICS

PREPARATION AND FABRICATION

27512 (UCRL—84303) Structure-property relationships of linear methyl-phenyl-vinyl siloxane terpolymers. Hammon, H.G.; Hoffman, D.M.; Jessop. E.S.; Kolb, J.R.; Riley, M.O. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 May 1980. Contract W-7405-ENG-48. 10p. (CONF-800814—2; CONF-800628—2). NTIS, PC A02/MF A01.

From American chemical society meeting; San Francisco, CA, USA (24 Aug 1980).

LLNL has an active interest in the synthesis and characterization of siloxane polymers with properties tailored to meet specific design requirements. We have synthesized a series of 15 random terpolymers of dimethyl-diphenyl-methylvinyl siloxane. In seven terpolymers the concentration of the methylvinyl repeat unit was varied from 0 to 5 weight percent maintaining phenyl content constant at 12 percent. The other eight terpolymers contained 0 to 18 weight percent phenyl repeat unit maintaining vinyl at one percent. As nearly as possible comparable molecular weights (5×10^5) were maintained. The gum stocks were reinforced with ~ 25 percent fumed silica. Silicones of different vinyl content were cured with a vinyl specific peroxide and characterized by swelling and mechanical properties. The moduli increased directly with vinyl concentration, but the longation to break decreased until at about two percent vinyl the rubber becomes extremely friable. Increasing the phenyl content in the silicone decreased the degree of crystallinity and increases the polymer class transition in accord with theoretical predictions. The major effect of incorporation of phenyl groups

is the elimination of the polymer's ability to crystallize at about three percent phenyl. This extends the rubbery plateau to the glass transition (-117°C) instead of the melting point (-44°C).

27513 (UCRL—84304) **Synthesis and characterization of new silicone condensation polymers.** Butler, N.L.; Hammon, H.G.; Jessop, E.S.; Kolb, J.R.; Riley, M.O. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 May 1980. Contract W-7405-ENG-48. 7p. (CONF-800814—1; CONF-800628—3). NTIS, PC A02/MF A01.

From American chemical society meeting; San Francisco, CA, USA (24 Aug 1980).

The LLNL has an active interest in the synthesis of new polysiloxanes as base polymers for cellular silicone materials in very specific design requirements. While the polymers which have been prepared via random equilibration of various cyclic tetrasiloxanes have adequate properties for certain applications, there is evidence to suggest that alternating block polysiloxanes prepared via condensation polymerization techniques have properties more desirable to our end uses as flexible foam materials. The synthetic sequence involves reactions of functionally terminated (amino and hydroxy) polysiloxane oligomers to produce alternating block (ABAB...) materials of high molecular weight dialkylamines as condensation by-products. The analysis and characterization of these block copolymers is reported upon. An additional topic of discussion is the functional endcapping of these poly(dimethyl-diphenyl-methyl vinyl) siloxane copolymers with dimethylvinylsilyl groups. This functional termination should provide a means of tying down any dangling polymer ends present through peroxide crosslinking.

STRUCTURE AND PHASE STUDIES

27514 **Neutron scattering study of the phases of TTF-TCNQ below 5 kbar.** Fincher, C.R. Jr.; Shirane, G.; Comes, R.; Garito, A.F. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B: Condens. Matter;* **21**: No. 11, 5424-5426(1 Jun 1980).

Recent transport data by Friend et al. and elastic neutron scattering data from Megtert et al. have shown a variety of interesting changes in the low-temperature properties of tetrathiafulvalene-tetracyanoquinodimethane (TTF-TCNQ) when under high pressure. As a further elucidation of this problem, we have used elastic neutron scattering to make a more detailed study of the pressure-temperature phase diagram up to pressures of 4.75 kbar. We report the pressure dependence of the structural transitions which occur at 49 and 38 K at P=1 bar. In addition, we describe a new low-temperature phase found for $3.25 < P < 4.0$ kbar.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 27510

27515 (BDX—613-2410) **Effect of preheat on molding compounds. Final report.** McFarland, J.W. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 33p. NTIS, PC A03/MF A01.

The effects of preheating the preforms and B-staging the raw materials were investigated for a silicone and a diallyl phthalate thermosetting molding compound. Preheating the preforms caused large increases in the mechanical and electrical properties of both compounds. Heat treating the raw materials had very little effect. Compression-molded specimens were 100% stronger than the transfer-molded ones for the silicone and 48% stronger for the diallyl phthalate.

27516 (BDX—613-2412) **Mechanical properties of polystyrene bead encapsulation foam.** Fossey, D.J. (Bendix Corp., Kansas City, MO (USA)). Mar 1980. Contract AC04-76DP00613. 33p. NTIS, PC A03/MF A01.

The tensile and compressive properties of polystyrene bead foam used as an encapsulant for electronic devices were determined for densities ranging from 0.3 to 0.6 g/cm^3. Data were generated for these properties at -54, 25, and 74°C. Data previously reported for 0.2 g/cm^3 are included.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 27159, 27515

27517 (SAND—80-0365) **Toward more accurate loss tangent measurements in reentrant cavities.** Moyer, R.D. (Sandia Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 36p. NTIS, PC A03/MF A01.

Karpova has described an absolute method for measurement of dielectric properties of a solid in a coaxial reentrant cavity. His cavity resonance equation yields very accurate results for dielectric constants. However, he presented only approximate expressions for the loss tangent. This report presents more exact expressions for that quantity and summarizes some experimental results.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 27571

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 27066, 27068, 27069, 27070, 27071, 27072, 27073, 27074, 27075, 27079, 27080, 27083, 27084, 27088, 27089, 27090, 27091, 27092, 27093, 27094

27518 **Laser annealing under the oxide layers in silicon.** Narayan, J. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Appl. Phys. Lett.;* **37**: No. 1, 66-68(1 Jul 1980).

Laser pulses have been used to study the growth and removal of dislocations underneath thin oxide layers in silicon. These observations provide clear evidence of melting under the oxide layer without disturbing the oxide layer on the surface. The thickness of melted regions increased with increasing of stacking faults were observed, presumably as a result of melting of the oxide layer and the introduction of oxide clusters in silicon.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 27003, 28134

27519 **Phase transition and rotational excitations in $Ni(NH_3)_4I_2$.** Eckert, J.; Press, W. (Brookhaven National Laboratory, Upton, New York 11973). EY-76-C-02-0016. *J. Chem. Phys.;* **73**: No. 1, 451-460(1 Jul 1980).

Neutron scattering techniques were used to investigate both the crystal structures and the rotational dynamics of the ammonia groups in $Ni(NH_3)_4I_2$ above and below the phase transition near 20 K. The phase transition involves orientational ordering of the ammonia groups and is accompanied by a distortion of the crystal lattice from cubic (space group Fm3m) to trigonal symmetry along with a doubling of the primitive cell. A deuterated sample was employed for the structural studies. Its transition temperature was found to be 26.5 +- 0.3 K. Extensive studies of the rotational dynamics of the NH_3 groups above the phase transition showed that their motion is best described as one-dimensional rotational diffusion about their trigonal axis. Diffusion constants derived from this analysis as a function of temperature exhibit increasing orientational correlations as the transition temperature is approached. At low temperatures the NH_3 groups perform one-dimensional tunneling motions. The resulting splitting of the librational ground state was determined to be 0.0634 +- 0.0014 meV in good agreement with the value derived from earlier specific heat measurements. A further excitation at 9 meV is interpreted as a transition to the first excited librational state.

27520 **Grain boundary etching in InP.** Hershenson, L.; Zanio, K. (Hughes Research Laboratories, 3011 Malibu Canyon Road, Malibu, California 90265). ET-78-01-3412. *J. Appl. Phys.;* **51**: No. 7, 3663-3665(Jul 1980).

Grain boundaries in bulk polycrystalline InP wafers are preferentially attacked by a 5 HCl:3HNO_3:4 HF etch. Canyons with depth > 10 μm and widths ~ 1 μm are the most common form of attack. Although the etch has effect on simple twin boundaries, preferential attack occurs at interfaces formed by multiple twinning events.

27521 **Inverted high-temperature quartz: unit cell parameters and properties of the α-β inversion.** Ghiorso, M.S.; Carmichael, I.S.E.; Moret, L.K. (Univ. of California, Berkeley). *Contrib. Mineral. Petrol.;* **68**: 307-323(1979).

The experimental data presented and discussed allow the following generalizations to be made: (1) The variability in the lattice parameters of natural volcanic quartz does not correlate with any other measurable physical property, within the limits of experimental error. (2) An increase in the α-β inversion temperature is inversely correlated to Al content, and provides a weak indication of the growth or equilibration temperature of quartz phenocrysts. (3) The α-β transition temperature hysteresis reflects sample preparation and is a function of grain size. It has a strong correlation with the enthalpy of the α-β transition which for zero hysteresis is taken to be 92.0 +- 1.4 cal/mol. In contrast for a single crystal the enthalpy change is 107.7 +- 1.4 cal/mol. (4) The discontinuities in various physical properties that occur at the α-β transition (e.g., instantaneous increase in the anharmonicity of the O lattice vibrations) are superimposed over a broader series of structural changes that are reflected in the behavior of the derivatives of free energy with respect to T and P, as a function of temperature.

27522 Structural phase transformations in dicesium sodium ferricyanide. Ryan, R.R.; Smyth, J.R. (Los Alamos Scientific Lab., NM). *Acta Crystallogr., Sect. B;* **35**: 264-265(1979).

A structural phase transformation ($P2_1/n \rightarrow P4/mnc$) has been observed for $Cs_2NaFe(CN)_6$ at 498 K. The structural changes are describable in terms of distortions involving the same phonon modes which are responsible for phase changes in the related $Cs_2LiM(CN)_6$ (M=Cr, Mn, Fe, Co, Ir) salts.

PROPERTIES

REFER ALSO TO CITATION(S) 27091, 27521, 27606, 27648

27523 (SAND—80-0632) **Impulse radar scanning of intact salt at the Avery Island Mine.** Cook, C.W. (Sandia Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 36p. NTIS, PC A03/MF A01.

A series of experiments was run in the Avery Island Mine to evaluate the capability of an impulse radar to locate anomalies and simulated waste targets in intact dome salt. Voids in salt were difficult to detect. On the positive side, metal targets and simulated waste (glass) were easily located in intact salt. Radar scanning at ranges of greater than 25 meters and short-range resolution of target positions to within a few centimeters were achieved.

27524 Degenerate four-wave mixing of 10.6-μm radiation in Hg/sub 1-x/Cd/sub x/Te. Jain, R.K.; Steel, D.G. (Hughes Research Laboratories, Malibu, California 90265). 4-L49-8221K-1. *Appl. Phys. Lett.;* **37**: No. 1, 1-3(1 Jul 1980).

We report observation of a large nonlinear optical susceptibility in HgCeTe for degenerate four-wave mixing of 10.6-μm radiation. Using pump pulses of 180 ns duration and 160 kW/cm² peak intensity, nonlinear reflection coefficients of oiver 10% have been observed. The experimentally measured value of chi/sup(³) is approximately 5.4 x 10^{-6} esu, in reasonable agreement with calculations based on a Drude model for the optically generated plasma. We have also observed nonlinear Fabry Perot effects in our samples.

27525 Electronic structure of zirconium monosulfide. Nguyen, T.; Franzen, H.; Harmon, B.N. (Ames Laboratory-USDOE and Departments of Chemistry and Physics, Iowa State University, Ames, Iowa 50011). W-7405-ENG-82. *J. Chem. Phys.;* **73**: No. 1, 425-437(1 Jul 1980).

The electronic structures of ZrS with the NaCl-type and the WC-type lattice structures were calculated by the LAPW method. The results are interpreted in terms of chemical bonding effects in the two forms of ZrS. The results of the calculations are compared with photoelectron spectroscopic and low-temperature heat capacity results. The agreement between the experimental and theoretical results is noted and the discrepancies are commented upon.

27526 Electrical properties of polycrystalline GaAs films. Yang, J.J.J.; Dapkus, P.D.; Dupuis, R.D.; Yingling, R.D. (Rockwell International Electronic Devices Division, Electronics Research Center, Anaheim, California 92803). EY-76-C-03-1202. *J. Appl. Phys.;* **51**: No. 7, 3794-3800(Jul 1980).

Electrical properties of Se- and Zn-doped polycrystalline GaAs deposited by metalorganic chemical vapor deposition on substrates of polycrystalline alumina and glass were investigated. Hall-effect and resistivity measurements were made over a wide range of temperature (77—420 K). The electrical activation energies were found by measuring the variation of resistivity and carrier mobility of the polycrystalline GaAs films with sample temperature. The resistivity and mobility were found to be temperature activated over a wide temperature range as exp(E/sub b/ /kT) and exp(-E/sub b/ /kT), respectively, with the same activation energy applying to both properties. The results have been interpreted in terms of a modified grain boundary trapping model.

27527 Microstructure-property relationships of rare-earth—zinc-oxide varistors. Williams, P.; Krivanek, O.L.; Thomas, G.; Yodogawa, M. (Department of Materials Science and Mineral Engineering, Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Appl. Phys.;* **51**: No. 7, 3930-3934(Jul 1980).

The microstructure and properties of ZnO varistors containing Ba, Co, and rare-earth—metal oxides, which give values of α [α=d(log I)/d(log V)] as high as 29, are examined. Mean ZnO grain size is 11 μm, and the grains are uniformly doped with Co. The barium and rare earth metals concentrate into 1.5-μm-wide particles embedded in a matrix of ZnO grains. Within the grains and at grain boundaries, the barium and rare-earth—metal concentration is below the detection limit of the energy-dispersive spectrometer technique (about 0.5%). No intergranular films, amorphous or crystalline, are detected, to within 10 A resolution. These results are shown to be consistent with the grain boundary charge depletion model for the voltage barrier formation and breakdown.

27528 Absorption coefficients of solid NH_3 from 50 to 7000 cm^{-1}. Sill, G.; Fink, U.; Ferraro, J.R. (Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona 85721). *J. Opt. Soc. Am.;* **70**: No. 6, 724-739(Jun 1980).

Thin-film spectra of solid NH_3 at a resolution of 1 cm^{-1} were used to determine its absorption coefficient over the range 50—7000 cm^{-1}. The thin films were formed inside a liquid N_2 cooled dewar using a variety of substrates and dewar windows. The spectra were recorded with two Fourier spectrometers, one covering the range from 1 to 4 μm and the other from 2.6 to 200 μm. The thickness of the films was measured with a laser interference technique. The absorption coefficients were determined by application of Lambert's law and by a fitting procedure to the observed spectra using thin-film theory. Good agreement was found with the absorption coefficients recently determined by other investigators over a more restricted wavelength range. A metastable phase was observed near a temperature of 90°K and its absorption coefficient is reported. No other major spectral changes with temperature were noted for the range 88—120°K.

27529 High field Faraday rotation of some Zn(VI) compounds. Fowler, C.M.; Caird, R.S.; Garn, W.B.; Erickson, D.J.; Freeman, B.L. (Los Alamos Scientific Lab., NM). *J. Less-Common Met.;* **62**: 397-404(1978).

Verdet coefficients at about 6.5°K were determined as a function of wavelength for single-crystal phases of ZnO, ZnSe and ZnS. The coefficients for all the materials studied here exhibit no magnetic field dependence below 100 T ZnO and ZnS were investigated to fields substantially above 100 T. For ZnS, the Verdet coefficients were found to decrease at higher fields. A similar behavior did not occur for ZnO at fields to 180 T.

RADIATION EFFECTS

27530 (UCRL—83089) **Comparison of cesium iodide and gold photocathodes for x-ray streak cameras.** Stradling, G.L.; Medecki, H.; Attwood, D.T.; Kauffman, R.L.; Henke, B.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1979. Contract W-7405-ENG-48. 10p. (CONF-791135—13). NTIS, PC A02/MF A01.

From 21. annual meeting of the American Physical Society; Boston, MA, USA (12 Nov 1979).

X-ray streak cameras at Lawrence Livermore Laboratory use gold transmission photocathodes for x-ray detection. Other photocathode materials which might provide improved sensitivity without loss of temporal resolution are of interest. Of particular interest are dielectrics such as cesium iodide. Simultaneous measurements of the sensitivity to 500 eV x-rays of both gold and cesium iodide photocathodes in the LLL Soft X-ray Streak Camera were made. Enhanced sensitivity with the CsI photocathodes is reported and no degradation of temporal resolution for 100 ps x-ray pulses is seen. We have established the optimum thickness for maximum sensitivity of gold photocathodes to be 100 A. The maximum sensitivity of cesium iodide was observed for photocathode thickness of 1100 A.

27531 Fast nondamageable laser-pulse detector using gaseous plasma. Bergmann, E.E.; McLellan, E.J.; Webb, J.A. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). W-7405-ENG.36. *Appl. Phys. Lett.;* **37**: No. 1, 18-19(1 Jul 1980).

We investigated pulsed laser radiation detectors in which the emf is generated by the plasma formed when the radiation is focused onto a solid metal surface. We report on measurements made with 10.6-μm laser pulses at peak power levels up to 100 MW. For an evacuated detector, we obtained signals >1 kV and subnanosecond rise times into a 50-Ω load. Detector performance is strongly modified with the introduction of a background gas. With one atmosphere of air, the detector produces signals on the order of 1 V and nanosecond response for pulse trains lasting 100 ns, and is thus a good qualitative beam monitor. With argon, krypton, or xenon at pressures on the order of 10 Torr, the detector generates "trigger pulses" of 250-V amplitude and <0.2-ns rise times. These detectors are indestructable.

27532 F-center fluorescence in neutron-bombarded sapphire. Jeffries, B.; Summers, G.P.; Crawford, J.H. Jr. (Department of Physics, Oklahoma State University, Stillwater, Oklahoma 74074). EY-76-S-05-4837;ER-78-S-05-5866. *J. Appl. Phys.;* **51**: No. 7, 3984-3986(Jul 1980).

The efficiency of the 3.0-eV photoluminescence band which results from optical excitation into the 6.1-eV F band in single-crystal sapphire is much weaker for F centers introduced by fast neutron bombardment than for those produced thermochemically (i.e., by either deliberate additive coloration or by coloration during growth). The luminescent efficiency has been monitored at room temperature following successive isochronal annealing stages up to 580 °C for samples exposed to ~10^{17} neutrons cm^{-2}. The relative emission intensity per F center increased rapidly as the F centers were thermally destroyed and reached a value at the upper end of the annealing range which was 40 times the preanneal value. It is

suggested that the initial relatively weak emission is due to concentration quenching which results from the highly inhomogeneous distribution of lattice defects, i.e., displacement cascades, produced by fast neutron bombardment.

CHEMISTRY

27533 (SAND—80-0639C) **Applications of high resolution inverse Raman spectroscopy.** Owyoung, A.; Esherick, P. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 19p. (CONF-800808—3). NTIS, PC A02/MF A01.

From 7. international conference on raman spectroscopy; Ottawa, Canada (4 Aug 1980).

The use of high-power, narrow-band lasers has significantly improved the resolving power and sensitivity of inverse Raman spectroscopy of gases. In this paper we shall describe this technique, illustrate its capabilities by showing some Q-branch spectra of heavy spherical tops, and survey some possible future applications.

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 26957, 27746

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 26940, 27010, 27971

27534 **Determination of selenium in environmental standard reference materials by a gamma-gamma coincidence method using Ge(Li) detectors.** Wangen, L.E.; Gladney, E.S.; Hensley, W.K. (Univ. of California, Los Alamos, NM). Contract W-7405-ENG-36. *Anal. Chem.;* **52**: No. 4, 765-767(Apr 1980).

A gamma-gamma coincidence technique is applied to the determination of low levels of selenium in NBS standard reference materials, using the ^{75}Se (n,γ) product. The method is shown to provide accurate determinations in a variety of materials. Removal of interfering γ rays at 136 and 264 keV due to ^{181}Hf and ^{182}Ta and suppression of Compton background by three to four orders of magnitude are realized by the coincidence counting procedure. Selenium concentrations ($\mu g\ g^{-1}$) of 0.024, 0.065, 0.084, 0.053, 1.1, 2.6, and 8.8 were determined for SRMs 1570, 1571, 1573, 1575, 1577, 1632, and 1633, respectively. Two sigma Se detection limits were approximately 10 to 20 ng g^{-1} for biological reference materials, and 50 to 100 ng g^{-1} for fly ash and coal using the conditions reported. 2 tables.

27535 **Comparative determination of carbon, nitrogen and hydrogen in environmental standard reference materials by instrumental combustion analysis and thermal neutron capture gamma-ray spectrometry.** Schofield, T.G.; Gladney, E.S.; Miera, F.R. Jr.; Trujillo, P.E. (Univ. of California, Los Alamos, NM). *Anal. Lett.;* **13**: No. A1, 75-83(1980).

Twelve reference materials have been analyzed by both procedures for carbon, nitrogen, and hydrogen concentrations. Both methods are shown to be accurate with time and cost advantages favoring combustion analysis. 3 tables.

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 27535, 27738

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 26984, 27010, 27534, 27636, 27747

27536 (LA-UR—80-1780) **NDA technique for the assay of wet plutonium oxalate.** Marshall, R.S.; Canada, T.R. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 8p. (CONF-800655—13). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

A method has been developed to quantitatively measure batches of wet plutonium oxalate. The method is based on a count of coincidence neutrons to which a correction is applied for the effects of neutron moderation by water. A therma-neutron coincidence counter (TNC) with two concentric rings of ^{3}He detectors provides the signal needed for the water correction. The signal is the ratio of neutron counts between the detector rings that changes with the percent of water in plutonium oxalate. To evaluate the measurement technique, 26 batches of plutonium oxalate were measured in an in-line TNC. The evaluation showed the measurements to be essentially unbiased and precise to 2.2%.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 26803, 27558, 27697, 28026

27537 (GJBX—113(80)) **Salton Sea NTMS 1° x 2° quadrangle area: supplemental data report. National Uranium Resource Evaluation Program, hydrogeochemical and stream sediment reconnaissance.** Heffner, J.D. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Apr 1980. Contract AC13-76GJ01664. 102p. (DPST—80-146-2S). PC $10.50/MF $3.50.

Supplemental analytical results for stream sediments and ground water are presented. The samples were collected as part of the SRL-NURE reconnaissance in the National Topographic Map Series (NTMS) Salton Sea 1° x 2° quadrangle. Results are reported for 24 elements (Ag, As, Ba, Be, Ca, Co, Cr, Cu, K, Li, Mg, Mo, Nb, Ni, P, Pb, Se, Sn, Sr, Th, W, Y, Zn, and extractable U) in sediments and 31 elements (Ag, Al, As, B, Ba, Be, Ca, Ce, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Sc, Se, Si, Sr, Th, Ti, V, Y, Zn, and Zr) as well as pH, alkalinity, and conductivity in ground water. Field data and NAA data will be open-filed when they are available.

27538 **Room temperature phosphorescence of nitrogen heterocycles adsorbed on silica gel.** Ford, C.D.; Hurtubise, R.J. (Univ. of Wyoming, Laramie). Contract DE-A520-79-LC01761. *Anal. Chem.;* **52**: No. 4, 656-662(Apr 1980).

The room temperature phosphorescence (RTP) of benzo[f]-quinoline adsorbed on several silica gel samples was investigated by luminescence, reflectance, and infrared spectroscopy to obtain a better understanding of the analytical conditions needed for strong RTP. The results showed that silica gel chromatoplates containing a polymeric binder with carboxyl groups were the best samples for inducing strong RTP from benzo[f]quinoline. The polymer itself was essential for inducing strong RTP. It was postulated that benzo[f]quinoline was adsorbed flatly on the surface with the carboxyl groups anchoring benzo[f]quinoline via hydrogen bonding with π electrons. 5 figures, 4 tables.

27539 **Determination of picogram amounts of Technetium-99 by resin bead mass spectrometric isotope dilution.** Anderson, T.J. (E.I. duPont de Nemours and Co., Aiken, SC); Walker, R.L. Contract DE-AC09-76SR00001. *Anal. Chem.;* **52**: No. 4, 709-713(Apr 1980).

An improved isotope dilution mass spectrometric technique has been developed for the analysis of ^{99}Tc in environmental samples. After spiking with ^{97}Tc, technetium is isolated from the sample by sequential ion-exchange chromatography and ion-association solvent extraction. The isolated technetium is finally concentrated onto a pair of anion exchange beads (diameter ~ 0.3 mm). The beads are individually analyzed on rhenium V filaments of a surface-ionization mass spectrometer. Determination of as little as 1 pg (0.017 pCi) has been achieved through the enhanced ionization efficiency afforded by the resin bead source. ^{99}Tc has been quantified in several environmental samples taken at the Savannah River Plant (SRP) site (a nuclear materials production complex) and its aqueous ^{99}Tc emission has been estimated. 3 figures, 3 tables.

27540 **Porphyrins. 40. Electronic spectra and four-orbital energies of free-base, zinc, copper, and palladium tetrakis(perfluorophenyl)porphyrins.** Spellane, P.J.; Gouterman, M.; Antipas, A.; Kim, S.; Liu, Y.C. (Univ. of Washington, Seattle). *Inorg. Chem.;* **19**: No. 2, 386-391(Feb 1980).

Absorption and emission spectra and emission quantum yields are given for free-base (H_2), Zn, Cu, and Pd derivatives of tetrakis(perfluorophenyl)porphyrin (TFPP). The four-orbital model is used to rationalize differences in the optical properties among the derivatives of TFPP and the same derivatives of porphine (P), octaethylporphyrin (OEP), and tetraphenylporphyrin (TPP). It is concluded from absorption data that the energy difference between the two excited singlets, i.e., $^{1}E(a/sub\ 2u/,e/sug\ g/) - {}^{1}E(a/sub\ 1u/,e/sub\ g/)$, decreases along the series Pd > Cu > Zn > H_2 and also along the series OEP > P > TFPP > TPP. The theory and date are reviewed, and it is concluded that the energy difference between the two excited triplets, i.e., $^{3}E(a/sub\ 2u/,e/sub\ g/) - {}^{3}E(a/sub\ 1u/,e/sub\ g/)$, also decreases along these series. However the condition of degeneracy, e.g., $^{1}E(a/sub\ 2u/,e/sub\ g/) - {}^{1}E(a/sub\ 1u/,e/sub\ g/) = 0$, occurs for different molecules in the singlet and triplet cases. Theory also suggests that if $^{3}E(a/sub\ 2u/,e/sub\ g/) > {}^{3}E(a/sub\ 1u/,e/sub\ g)$, the molecule should form a $^{2}A/sub\ 1u/$ cation radical and if $^{3}E(a/sub\ 2u/,e/sub\ g/) < {}^{3}E(a/sub\ 1u/,e/sub\ g/)$ the molecule should form a $^{2}A/sub\ 2u/$ radical. 4 figures, 2 tables.

27541 **Comparative mass spectrometry of the group 6B hexacarbonyls and pentacarbonyl thiocarbonyls.** Michels, G.D.; Flesch, G.D.; Svec, H.J. (Ames Lab., IA). *Inorg. Chem.;* **19**: No. 2, 479-485(Feb 1980).

Mass spectra, ionization energies, fragmentation energies, ionic and neutral dissociation energies, and heats of fo mation for the title compounds are measured and compared. Substit.tion of CS for CO in going from $M(CO)_6$ to $M(CO)_5CS$ results in (a) a slight modification of the mass spectra, if only the M(CO)/sub n/CS^+ and

M^+ ions are considered, (b) a lowering of the ionization energies by 0.1 to 0.4 eV, (c) a reduction of approximately 0.1 eV in the average M-CO bond energies in both the molecule and the molecular ion, and (d) a reduction of 3.0 +- 0.3 eV in the heats of formation of the molecules. Within each molecule or molecular ion the M-CS bond is stronger than the M-CO bonds by 1.5 to 2.0 eV. Both the M-CS and the M-CO bonds increase in strength in going from Cr to Mo to W. Comparison of calorimetric and mass spectrometric data for $M(CO)_6$ indicates that each neutral CO fragment leaves the ionization site in its first vibrationally excited state. 10 tables.

27542 (UCRL-Trans—11554) **Quantitative gas analysis of sulfur dioxide in nitrogen by Fourier transform infrared spectrophotometer.** Koga, Y.; Sugie, M.; Kondo, S.; Saeki, S. Translated from *Jpn. Anal.;* **28**: 298-303(1979). 21p. NTIS, PC A02/MF A01.

A method for quantitative gas analysis of sulfur dioxide contained in nitrogen using the Fourier transform infrared spectrophotometer has been established. On account of the strong adsorption properties of sulfur dioxide, the measuring method adopted is one in which the sample is made to flow inside the cell and in the sampling system. Measurements were conducted with a total pressure of 3 atm of the sample gas and with a spectrophotometer resolving power of 0.5 cm^{-1}. This method has a range of application to sulfur dioxide concentrations ranging from 15% to 300 ppM, and the precision of analysis (2σ) was 1.9%.

27543 (UCRL-Trans—1591) **Analysis of minute quantities of aluminum in sea water (fluorometric determination of trace amount of aluminum in sea water).** Nishikawa, Y.; Hiraki, K.; Morishige, K.; Tsuchiyama, A.; Shigematsu, T. Translated from *Jpn. Anal.;* **17**: 1092-1097(1968). 16p. NTIS, PC A02/MF A01.

0.5 ml of a 0.01% lumogallion solution is added to samples containing 0.003-2 μg of aluminum, the pH is adjusted to 5.0 (using a buffer solution of ammonium acetate and acetic acid), the reaction is carried out for 20 minutes at 80°C, and then fluorophotometric determinations are performed. Of the elements present in sea water, iron has a disturbing effect. Therefore, it is advisable to use calibration curves prepared in the presence of iron. This method was employed to find the amounts of aluminum present in sea water and the particle size distribution of aluminum present in suspension. Results also showed that the method of cooling and freezing samples for analysis of aluminum is relatively effective as a method for storing them.

27544 (UCRL-Trans—1590) **Fluorophotometric determination of aluminum and gallium with lumogallion.** Nishikawa, Y.; Hiraki, K.; Morishige, K.; Shigematsu, T. Translated from *Jpn. Anal.;* **16**: 692-697(1967). 16p. NTIS, PC A02/MF A01.

Both aluminum-lumogallion complexes and gallium-lumogallion complexes emit a stable fluorescence in slightly acidic solutions, and their fluorescent spectrum is within the range of 500 to 650 mμ. We made a fundamental study of the use of this fluorescence in fluorophotometric determination of aluminum and gallium. The aluminum complexes displayed their maximum fluorescent intensity at pH 5, and the gallium complexes displayed theirs at pH 3. It was found possible to determine them quantitatively within an error of 2% when they had concentrations within the range of 0.1-2 μg Al/25 ml and 0.5-5 μg Ga/25 ml, respectively. If the amyl alcohol extraction method is used, it is possible to determine quantities of even smaller amounts of aluminum or gallium. This method has an extremely good sensitivity and precision, and it is among the best of the methods of determining aluminum and gallium using 0,0'-dihydroxyazo compounds as the fluorescent reagents.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 26803

INORGANIC AND PHYSICAL CHEMISTRY

27545 (MLM—2737(OP)) **General valence bond theory for chemical reactions: formulation of the SOGVB wavefunction.** Bobrowicz, F.W. (Mound Facility, Miamisburg, OH (USA)). 1980. Contract AC04-76DP00053. 17p. (CONF-800726—1). NTIS, PC A02/MF A01.

From MCHF workshop; College Station, TX, USA (14 Jul 1980).

The formulation of an MCSCF wavefunction of the GVB (generalized valence - bond) type designed to deal with the changes occurring during chemical reactions is presented. As such, this wavefunction is labeled SOGVB (strongly orthogonal generalized valence - bond), overcomes one of the deficiencies of the more familiar Perfect-Pairing GVB wavefunction (GVB-PP) while retaining much of the computational simplicity of the Perfect-Pairing approximation.

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 27565, 27675

27546 (COO—4426-3) **Measurements of gas phase reaction rates: D + HX and NO + O_3. Progress report, September 1, 1979-August 31, 1980.** Gordon, R.J. (Illinois Univ., Chicago (USA)). May 1980. Contract AS02-77ER04426. 13p. NTIS, PC A02/MF A01.

Objective of this project is to measure the rate constants of two types of chemical processes: the reactions of atoms with small molecules and the vibrational relaxation and chemical reactions of ozone with various molecules. For the first part, a temperature controlled flash photolysis - resonance fluorescence apparatus is operational, and preliminary measurements of Cl + H_2, D_2 and CH_3Br have been made. A complete study of the abstraction, exchange, and reverse reactions of Cl + H_2 and Cl + D_2 is under way. In the second study the rate of vibrational relaxation of ozone by H_2O and D_2O were measured in a fast flow apparatus. An anomalous negative temperature dependence for both molecules and an inverse isotope effect were explained in terms of a metastable complex model of energy transfer. Also being investigated is the reaction of NO + O_3 in a large capacity flow reactor built for this study.

27547 (DOE/ER/04948—1) **Energies and bonding in manganese phosphides. Annual progress report, July 1, 1979-June 30, 1980.** Myers, C.E.; Jung, E.D.; Simpson, D.J.; Patterson, E.L.; Melzer, J.I. (State Univ. of New York, Binghamton (USA). Dept. of Chemistry). Mar 1980. Contract AS02-78ER04948. 6p. NTIS, PC A02/MF A01.

Manganese monophosphide and other first row transition metal phosphides have been studied by x-ray photoelectron spectroscopy in collaboration with colleagues at Ames Laboratory. Electron binding energies of both valence-conduction band and core level electrons show an evolution of metallic behavior in the series ScP, TiP, VP, MnP, FeP, and in the series FeP, Fe_2P, Fe_3P. Phosphorus dissociation pressure measurements on MnP lead to: 4MnP/sub (s)/ = $2Mn_2P$/sub (s)/ + P_2/sub (g)/, $\Delta H°_{298\ 15}$/sub R/ = 35.1 +- 1.0 kK when the data are treated by the third law method using estimated entropies. Combination of this result with published data yields: $\Delta H°$/sub f/ $_{298\ 15}$(MnP) = -12.5 +- 0.6 kK which is in satisfactory agreement with the published value: $\Delta H°$/sub f/ $_{298\ 15}$ = -11.6 kK. The apparently low value of the atomization enthalpy of MnP is confirmed and is attributed to a high valence state preparation energy. A study of the congruent vaporization of Mn_2P has been initiated. Apparatus for solid state galvanic cell measurements on metal phosphide systems has been fabricated and assembled. Studies are proceeding on a high pressure synthesis of MnP_3.

27548 (LBL—8937) **LBL manual for the EQ chemical simulation programs.** Iqbal, P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1979. Contract W-7405-ENG-48. 35p. NTIS, PC A03/MF A01.

Portions of document are illegible.

This manual covers the computer programs EQF, EQS,EQ3, ND EQ6. The states covered are aqueous solution, minerals, gases, and solid solutions. The data base and its manipulation are also discussed in this document. (DLC)

27549 (MHSMP—80-27) **High performance size exclusion chromatography (V) molecular characterization of silicone fluids and gums by computer deconvolution.** Kohn, E.; Ashcraft, R.W. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). May 1980. Contract AC04-76DP00487. 31p. NTIS, PC A03/MF A01.

The molecular parameters of 22 silicone fluids, three gums and two fractions of one of the fluids, were determined by high performance size exclusion chromatography (HPSEC). The distribution curves of the silicon fluids were bimodal or multi-modal and bimodal curves were deconvoluted by a method previously described. For the deconvolution of the multimodal curves, a special adaptation of the Simplex method was developed and applied. Evaluation of the molecular weight parameters involved the calibration of a set of columns with a large number of polystyrene standards and adjustments to silicone equivalency by comparison of the calculated viscosity average molecular weights of the entire distributions with data from direct viscometric measurements. The Q-value for the silicon fluids obtained by this procedure was 31. The multimodal distribution of the fluids showed that they are mixtures, with at least some components deliberately added by the supplier. The distinct molecular components of the mixtures were separated and charaterized by means of the Simplex deconvolution procedure. The silicon gums were found to be unimodal in the principal component but contained two lower molecular weight trace impurities. Fractional precipitation of one of the silicon fluids resulted in nearly complete separation of the components, as demonstrated by HPSEC.

27550 (MLM—2698) **Thermal conductivity of consolidated Al/Cu_2O thermites.** Miller, G.D.; Haws, L.D. (Mound Facility, Miamisburg, OH (USA)). 17 Jun 1980. Contract AC04-76DP00053. 17p. NTIS, PC A02/MF A01.

Knowledge of the thermal conductivity, λ, of Al/Cu_2O consolidated thermites is required in order to model the reaction and, in turn, understand and predict thermite burn rates, ignition temperatures, and sensitivities. Two methods, laser-flash and comparative, were evaluated. The comparative method was found to be the method of choice. Results of the λ measurements are reported as functions of temperature, part density, and aluminum particle shape.

27551 (RHO-SA—109) **Matrix effects on the Raman analytical lines of oxyanions.** Miller, A.G.; Macklin, J.A. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations; Washington Univ., Seattle (USA). Dept. of Chemistry). Jul 1979. Contract AC06-77RL01030. 32p. (CONF-790666—8). NTIS, PC A03/MF A01.

From 34. Northwest regional meeting of the American Chemical Society; Richland, WA, USA (13 Jun 1979).

The characteristics of Raman analytical lines are frequently affected by changes in the chemical environment of the vibrating molecule. Aqueous solutions containing pairs of the following anions, aluminate, ClO_4^-, CrO_4^{2-}, NO_3^-, PO_4^{3-}, SO_4^{2-}, and NO_2^- have been studied as a function of increasing Na^+ concentration. Typical effects noted are line broadening and a blue shift of the A_1 lines of high-symmetry oxyanions with increasing sodium content. Spectral changes are generally interpreted in terms of contact ion pair formation with sodium. Analytical ratios derived from the analytical lines of analyte and internal standard oxyanions are evaluated in terms of matrix independent character. The classical peak area ratio is not necessarily the best analytical measure of concentration. 19 figures.

27552 (SAND—80-8689) **Heat of formation of $CaCl_2.2CH_3OH$ and $CaCl_2.2C_2H_5OH$ by solution calorimetry.** Carling, R.W.; Wondolowski, A.T.; Macmillan, D.C. (Sandia National Labs., Livermore, CA (USA)). Jun 1980. Contract AC04-76DP00789. 14p. NTIS, PC A02/MF A01.

In recent years many types of materials have been proposed for the storage of energy. In all storage concepts the amount of energy that can be stored is of utmost importance. Recent thermochemical research has focused on salt hydrates and ammoniates and only limited data exists for the alcoholates of interest in this work. Therefore, the enthalpies of formation of $CaCl_2.2CH_3OH$ and $CaCl_2.2C_2H_5OH$ have been determined by solution calorimetry as -(1309 +- 2) and -(1392 +- 2) kJ mol^{-1}, respectively.

27553 **Comparison of variational transition state theory and the unified statistical model with vibrationally adiabatic transmission coefficients to accurate collinear rate constants for T+HD→TH+D.** Garrett, B.C.; Truhlar, D.G.; Grev, R.S.; Walker, R.B. (Chemical Dynamics Laboratory, Kolthoff and Smith Halls, Department of Chemistry, University of Minnesota, Minneapolis, Minnesota 55455). *J. Chem. Phys.;* **73**: No. 1, 235-240(1 Jul 1980).

We report accurate quantum mechanical reaction probabilities, rate constants, and activation energies for collinear T+HD→TH+D on an accurate potential energy surface. We also report approximate calculations by conventional transition state theory, the unified statistical model, and three versions of variational transition state theory. We include tunneling contributions by two quantum mechanical and three semiclassical methods based on a vibrationally adiabatic treatment of reaction in the ground state. The most accurate approximate calculations for temperatures up to 1500 K are the improved canonical variational theory with Marcus—Coltrin path vibrationally adiabatic ground state (MCPVAG) transmission coefficient and the microcanonical variational theory with MCPVAG transmission coefficient. These two theories and the unified statistical theory with MCPVAG transmission coefficient are accurate within 41% for 400—2400 K but underestimate the rate constant by factors of 2.0 and 2.6 at 300 and 200 K, respectively. The two most accurate approximate theories overestimate the energy of activation for 300—1000 K by 0.46 kcal/mole. The unified statistical model with MCPVAG transmission coefficient produces slightly less accurate rate constants for 600—1500 K and more accurate ones at 2400 K. It overestimates the activation energy for 300—1000 K by only 0.40 kcal/mole.

27554 **Coordination (hydration) of rare earth ions in aqueous chloride solutions from x-ray diffraction. III. $SmCl_3$, $EuCl_3$, and series behavior.** Habenschuss, A.; Spedding, F.H. (Ames Laboratory—USDOE, Department of Physics, and Department of Chemistry, Iowa State University, Ames, Iowa 50011). *J. Chem. Phys.;* **73**: No. 1, 442-450(1 Jul 1980).

The inner sphere water coordination of Sm^{3+} and Eu^{3+} in concentrated (3.23 m) aqueous chloride solutions was obtained from x-ray diffraction measurements at 25 °C. The average water coordination is 8.8 for Sm^{3+} and 8.3 for Eu^{3+}. The average RE^{3+}—H_2O distances are 2.474 A for Sm^{3+} and 2.450 A for Eu^{3+}. The average RE^{3+} xxxCl^- ion pair distances occur near 4.9 A. A careful examination of the x-ray diffraction results for ten rare earth chloride solutions indicates that the inner sphere water coordination of the rare earth ions in aqueous solutions decreases from nine to eight due to the decreasing rare earth ionic radii. The ions La^{3+} through Nd^{3+} are nine coordinated, those between Nd^{3+} and Tb^{3+} are transitional between nine and eight, and those from Tb^{3+} to Lu^{3+} are eight coordinated.

27555 **Improved canonical variational theory for chemical reaction rates. Classical mechanical theory and applications to collinear reactions.** Garrett, B.C.; Truhlar, D.G. (Univ. of Minnesota, Minneapolis). *J. Phys. Chem.;* **84**: No. 7, 805-812(3 Apr 1980).

A new variational theory of chemical reaction rates, called improved canonical variational theory (ICVT), provides a bound on the classical mechanical equilibrium reaction rate. As compared to canonical variational theory (the method of free-energy curves) it involves a more accurate treatment of the threshold region. Classically the method consists of eliminating all contributions to the generalized transition-state theory rate constant from energies below the energetic reaction threshold and then estimating the contribution from the remaining truncated canonical ensemble by variational optimization of a generalized transition state dividing surface in configuration space. The ICVT is illustrated and tested by applications to classical collinear reaction rates in several systems. Tests of the unified statistical theory for two new reactions are also provided.

27556 **Coordinately unsaturated metal clusters. A neutron diffraction study of the crystal and molecular structure of the trimeric rhodium complex $(HRh[P(OCH_3)_3]_2)_3$.** Brown, R.K. (Argonne National Lab., IL); Williams, J.M.; Sivak, A.J.; Muetterties, E.L. *Inorg. Chem.;* **19**: No. 2, 370-374(Feb 1980).

The molecular strcutre of $(HRh[P(OCH_3)_3]_2)_3$ has been determined by using neutron diffraction techniques [T = 110 K]. The trimeric rhodium complex is monoclinic, space group $P2_1[C_2^2$, No. 4], with a = 10.792 (6) A, b = 13.438 (8) A, c = 13.438 (8) A, β = 91.64 (4)°, V/sub c/ = 1948.02 A^3, and d/sub calcd/ = 1.801 g cm^{-3} for Z = 2. The neutral molecule consists of a triangular array of Rh atoms each bonded in an approximately square-planar fashion to two terminal $P(OCH_3)_3$ groups and two bridging hydride ligands. The Rh-Rh separations involving single hydrogen bridges are 2.803 (7), 2.780 (6), and 2.856 (8) A and the average Rh-H/sub b/ distance is 1.76 (3) A. The bridging Rh-H/sub b/ separations reported here are the first interactions to be characterized structurally with neutron crystallographic techniques (T = 110 K). A discussion of the origin of the structural distortion from planarity of the $(HRhP_2)_3$ cluster core is presented. 4 figures, 3 tables.

27557 **Noncorrelation of Dq and E/sub 1/2/ in metal complexes. The importance of the spherical ligand field term.** Lintvedt, R.L.; Fenton, D.E. (Wayne State Univ., Detroit, MI). *Inorg. Chem.;* **19**: No. 2, 569-571(Feb 1980).

There are several studies in which the redox potentials vary significantly (1-2 V) in a series of closely related complexes containing the same metal ion. Within these series Dq may or may not change by an appreciable amount, thereby casting considerable doubt on the concept that changes in Dq are responsible for changes in E/sub 1/2/. Other bonding parameters such as the repulsive spherical ligand field term, V/sub s/, are potentially much more important and are expected to be sensitive to subtle changes in the ligands. 2 tables.

27558 **Study of ruthenium in zeolite-y by x-ray photoelectron spectroscopy.** Pedersen, L.A.; Lunsford, J.H. (Texas A & M Univ., College Station). *J. Catal.;* **61**: No. 1, 39-47(Jan 1980).

Ruthenium-exchanged NaY zeolites were studied with x-ray photoelectron spectroscopy in order to determine changes in the location and state of the Ru after subjecting the samples to both oxidizing and reducing environments. When O_2 was excluded from the system, ruthenium remained inside the zeolite cavities following reduction in H_2 and after the zeolite had catalyzed the methanation reaction. At elevated temperatures, before or after reduction, the presence of O_2 resulted in the formation of RuO_2 on the external surface of the zeolite. The peak intensity of the Ru 3d/sub 5/2/ line increased by more than a factor of five when the ruthenium migrated to the surface. Positive binding energy shifts of approximately 1 eV were detected for small clusters (<10 A) of reduced ruthenium when compared with larger metal particles within the zeolite or on its external surface. 22 references, 4 figures, 2 tables.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 26946, 26947

27559 (CONF-800427—15) **Tritium isotope separation from light and heavy water by bipolar electrolysis.** Petek, M.; Ramey, D.W.; Taylor, R.D.; Kobisk, E.H. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 19p. NTIS, PC A02/MF A01.

From Tritium technology in fission, fusion, and isotopic application; Dayton, OH, USA (29 Apr 1980).

A process for separating tritium from light and heavy water is described. Hydrogen is transferred at and through bipolar electrodes

at rates H > D > T. In a cell containing several bipolar electrodes placed in series between two terminal electrodes, a flow of hydrogen is established from the terminal anode compartment toward the terminal cathode. An electrolyte feed containing tritium is continuously added to the system and is subsequently transported countercurrent to the hydrogen mass transfer. A cascaded system is established, in which effluent streams enriched and depleted in tritium can be withdrawn. The voltage drop is smaller at any bipolar electrode as compared to the voltage for normal electrolysis. Cell design is compact because isotope separation occurs at bipolar electrodes without evolution of gas. Isotope separation was demonstrated in laboratory cells where a steady-state tritium concentration gradient was attained. This gradient was in agreement with concentrations calculated from a derived mathematical model.

27560 Crossed-beam study of the reaction $H_3O^+(D_2O,H_2O)D_2HO^+$. Ryan, P.W. (Univ. of Utah, Salt Lake City); Blakley, C.R.; Vestal, M.L.; Futrell, J.H. *J. Phys. Chem.;* **84**: No. 6, 562-567(20 Mar 1980).

The molecular dynamics of the reaction $H_3O^+(D_2O,H_2O)D_2HO^+$ were investigated at 0.68, 1.96, 3.45, and 4.99 eV relative kinetic energy. The equivalent reaction with isotopic exchange $H_3O^+(D_2O,HDO)H_2DO^+$ was investigated at 0.65 eV. Principal features of the angular dependence are rationalized in terms of a single reaction model which assumes proton transfer at large distances under the influence of a smoothly varying long-range empirical potential, $V(R) = 2250e^{-3}$ 4/sup R/ + $5000R^{-12}$-$180R^{-6}$-$32R^{-4}$. Velocity distributions are quite broad at all energies, indicating extensive exchange of internal and translational energy. At the lowest energies investigated many of the collisions involve a time duration on the order of the rotational period of the collision intermediate. Extensive isotopic exchange is noted, and the differential cross-section contour plot approaches the symmetry characteristic of a persistent complex.

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 27555, 27558, 27567

27561 (BNL—27438) **Resonance fluorescence kinetic study of the $O(^3P) + CH_4$ reaction over the temperature range 474K to 1156K.** Klemm, R.B.; Tanzawa, T.; Skolnik, E.G.; Michael, J.V. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 26p. (CONF-800809—1). NTIS, PC A03/MF A01.

From 18. combustion symposium; Waterloo, Canada (17 Aug 1980).

The bimolecular rate constant for the reaction of $O(^3P)$ with CH_4 was measured directly over a wide range in temperature in a study that utilized two independent experimental techniques. The flash photolysis-resonance fluorescence method was employed to obtain rate constants at 474K and 520K at total pressure (in argon diluent) of 100 to 200 torr. At higher temperatures (548K to 1156K), a discharge flow-resonance fluorescence apparatus equipped with a quartz tube was employed. Rate data were obtained, using both techniques, not only under pseudo-first-order conditions but also free from the effects of secondary reactions. Stoichiometric corrections were thus not applied to the derived rate constants. The results at thirteen temperatures yield a linear Arrhenius plot that is described by the expression: $k_1(T) = (2.15 +- .30) \times 10^{-10} \exp(-10872 +- 192/RT)$ $cm^3molec^{-1}s^{-1}$.This result is compared to previous ones and an extrapolation to higher temperatures, based on a collision model, is discussed. Finally, the present data were combined with the shock tube results of Brabbs and Brokaw, and Roth and Just to obtain the following expression that fits the results of all three studies over the temperature range 475 to 2205K: $k_1(T) = (5.28 +- .15) \times 10^{-12}$ T/sup 1/2/ exp (-10302 +- 48/RT) $cm^3molec^{-1}s^{-1}$.

27562 (DOE/LETC/RI—80/10) **^{13}C NMR chemical shift assignments for gammacerane (tetrahymane).** Netzel, D.A.; Linn, D.E. (Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center). Jul 1980. 12p. NTIS, PC A02/MF A01.

The carbon-13 NMR chemical shift values were obtained and assigned for each carbon atom of the pentacyclic triterpane gammacerane. Thirteen resonances of nearly unit intensity and one resonances of approximately two intensity units were observed which supports the proposed C_2 symmetry. The assignments were made by comparison with similar molecules and off-resonance decoupling. Relative to podocarpane C-7 and C-9 resonances of gammacerane were found to be shifted upfield instead of the expected downfield shift. These shifts are attributed to subtle conformational effects and an accentuated γ-effect due to the rigidity of the carbon skeleton.

27563 (SAND—80-1370C) **Ultra high resolution inverse Raman spectroscopy of methane in a CW free expansion jet.** Valentini, J.J.; Esherick, P.; Owyoung, A. (Los Alamos Scientific Lab., NM (USA); Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 4p. (CONF-800614—2). NTIS, PC A02/MF A01.

From 11. international quantum electronics conference; Boston, MA, USA (23 Jun 1980).

An ultra-high resolution inverse Raman spectrum of $^{12}CH_4$ has been obtained in a cw free-expansion jet in which the gas has been cooled into a non-Boltzmann distribution of three rotational levels corresponding to the meta, para and ortho nuclear spin states.

27564 Carbon-13 spin-lattice relaxation in condensed aromatic compounds. Alger, T.D. (Utah State Univ., Logan); Hamill, W.D. Jr.; Pugmire, R.J.; Grant, D.M.; Silcox, G.D.; Solum, M. *J. Phys. Chem.;* **84**: No. 6, 632-636(20 Mar 1980).

Several aromatic compounds (naphthalene, phenanthrene, pyrene, acenaphthene, and xanthone) have been studied at 25.1 and 75.3 MHz and 33°C. The ^{13}C spin-lattice relaxation measurements, T_1, are measured at the two frequencies along with determinations of the nuclear Overhauser enhancement (NOE). Independent estimations of the relaxation contributions are made for the dipolar and chemical shift anisotropy mechanisms. For the carbon-13 nuclei with attached protons, the NOE measurements range from a low of 2.7 to a maximum value of 3.0 (dominated by dipolar relaxation), and the values of T_1 are in the range of 3 to 11 s. Since dipolar mechanisms dominate, these values are relatively unaffected by field variations. In contrast, the values of the NOE parameter for nonprotonated carbons vary from 1.1 to 2.5. The average value of NOE in such cases is about 2.1 at 25.1 MHz and 1.5 at 75.3 MHz. For these nonprotonated carbons, the relative contributions of T_1/sup D/ and T_1/sup CSA/ at 25.1 MHz are approximately equal and relatively large (greater than 100 s and as large as 300 to 1000 s). In contrast, at 75.3 MHz the $1/T_1$/sup CSA/ contribution dominates these nonprotonated carbons. The chemical shift anisotropic relaxation time T_1/sup CSA/ is in the range of 30 to 90 s at this higher field strength. Chemical shift anisotropies similar to those measured in simple aromatic compounds (200 to 250 ppM) are adequate to account for the observed values of T_1/sup CSA/.

27565 Hydrodesulfurization of thiophenic compounds: the reaction mechanism. Kwart, H.; Schuit, G.C.A.; Gates, B.C. (Univ. of Delaware, Newark). *J. Catal.;* **61**: No. 1, 128-134(Jan 1980).

It has often been assumed that catalytic hydrodesulfurization of thiophene and related compounds proceeds via a one-point end-on adsorption involving bonding of the sulfur atom with Mo ions at an anion vacancy on the catalyst surface. This interpretation is inadequate, failing to account for hydrogen-deuterium exchange results, the reactivities of benzothiophene and dibenzothiophene, and the small steric effects of methyl substituents on the adsorption and reaction of compounds in the thiophene, benzothiopene, and dibenzothiophene families of homologs. An alternative mechanism, presented here, involves a multipoint adsorption of the reactant, with a C=C bond interacting with a Mo cation, and the S atom of the reactant interacting with an S ion on the surface. The new mechanism accounts for the observed deuterium exchange and hydrodesulfurization reactions and is consistent with the observed steric effects. 24 references, 5 figures.

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 27566

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 27565

27566 Magnetic isotope effect on the thermolysis of 9,10-diphenylanthracene endoperoxide as a means of separation of ^{17}O from ^{16}O and ^{18}O. Turro, N.J.; Chow, M.F. (Columbia Univ., New York, NY). *J. Am. Chem. Soc.;* **102**: No. 3, 1190-1192(30 Jan 1980).

The results appear to be consistent with the postulate that the thermolysis of 9,10-diphenylanthracene endoperoxide (DPA-O_2) produces a mixture of singlet oxygen and triplet oxygen as primary products via an initial singlet diradicaloid intermediate which can either fragment to yield singlet oxygen or intersystem cross to yield a triplet diradicaloid which can fragment to yield triplet oxygen. When the singlet diradicaloid possesses an ^{17}O atom which can interact, via hyperfine coupling, with an electron spin, the rate of intersystem crossing is accelerated relative to the rate for singlet diradicaloids that possess only ^{16}O or ^{18}O atoms. The experimental manifestations of this magnetic isotope effect are a lower quantum yield for singlet oxygen formation in ^{17}O-enriched DPA-O_2 and a selective isotopic enrichment of ^{17}O in the untrappable molecular oxygen generated in the thermolysis of DPA-O_2. These results appear to represent the first of selective separation of a middle isotope by a chemical process. 1 table, 3 figures.

ELECTROCHEMISTRY

REFER ALSO TO CITATION(S) 27298

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 27065, 27119, 27120, 27570, 27756, 27764

27567 Formation of vinylidenecarbene intermediates in multiple infrared photon elimination reactions. Reiser, C.; Steinfeld, J.I. (Massachusetts Inst. of Technology. Cambridge). Contract EY-76-S-02.2793. *J. Phys. Chem.;* **84**: No. 6, 680-681(20 Mar 1980).

Studies of the gas phase reactions of the formation of vinylidenecarbene by the elimination of HCl due to the multiple infrared photon excitation (MIRPE) of α-chloro olefins have been extended to the study of substituted vinyl chorides (R = CH_3, F) to determine if the reaction could be slowed sufficiently to permit the vinyldienecarbene to exist as a long-lived intermediate. Results of MIRPE tests on 1-chloro-2-methylpropene (I) and 2-chloro-1,2-difluorethylene(II) are reported. The compounds were photolyzed with CO_2 lasers either alone or in combination with other gases. The gaseous products were analyzed by gas chromatography. The principle photolysis products from I were HCl and butadiene with small amounts of allene, 2-butyne, and diacetylene, and photolysis in the presence of CH_3OH, H_2O, NH_3, H_2S, or D_2S yielded no addition products. Behavior of II was very different under the same conditions. The principal photolysis products were HCl, C_2F_4, and C_2F_3H; and in the presence of added H_2S or CH_3OH, the products are $C_2F_2H_2$, C_2F_3H, and C_2F_4. The results indicate that for photolysis of I, $(CH_3)_2C{=}C$ rearranges very quickly, but the species $F_2C{=}C$ arising from photolysis of II is very long-lived with essentially no rearrangement taking place. (BLM)

27568 Ulraviolet spectrum and reaction kinetics of the formyl radical. Hochanadel, C.J.; Sworski, T.J.; Ogren, P.J. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *J. Phys. Chem.;* **84**: No. 3, 231-235(7 Feb 1980).

A transient ultraviolet absorption attributed to the formyl radical, HCO, was produced by the flash photolysis of water vapor in the presence of CO. For CO saturated with H_2O at a total pressure of 1 atm, the formation of HCO is complete within ~ 60 μs, after which it undergoes second-order decay, with $k/\epsilon(230\ nm) = 1.5 +- 0.2) \times 10^7\ cm\ s^{-1}$. During the relatively slow formation reaction ($H + CO(+M) \rightarrow HCO$), the competing reaction $H + HCO \rightarrow H_2 + CO$ is significant. By employing the $H_2O + CH_4$ system as an actinometer to determine the amount of H_2O dissociated by the flash (discussed elsewhere) and by computer modeling the observed formation and decay of HCO as a function of CO pressure, the following absolute rate constants were obtained: $k_3(H + CO(+M) \rightarrow HCO) = (3.6 +- 0.9) \times 10^7\ M^{-2}\ s^{-1}$ for M = CO, $(5.8 +- 0.6) \times 10^7\ M^{-2}\ s^{-1}$ for M = CH_4, and $(3.8 +- 0.4) \times 10^7\ M^{-2}\ s^{-1}$ for M = H_2, $k_4(HCO + HCO \rightarrow products) = (1.4 +- 0.3) \times 10^{10}\ M^{-1}\ s^{-1}$, and $k_5(H +- HCO \rightarrow products) = (6.9 +- 1.7) \times 10^{10}\ M^{-1}\ s^{-1}$. The molar extinction coefficient $\epsilon(HCO, 230\ nm) = 941 +- 171\ M^{-1}\ cm^{-1}$.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 26968

27569 ESR study of an α-bromofluoro π-radical: Determination of the relative signs of the hyperfine and quadrupole couplings. Muto, H.; Kispert, L.D. (Chemistry Department, The University of Alabama, Tuscaloosa, Alabama 35486). *J. Chem. Phys.;* **73**: No. 1, 81-86(1 Jul 1980).

An ESR study has been carried out for the bromofluoro alkyl π-radical, CBrFCOOH, trapped in x-ray irradiated bromofluoroacetic acid crystals. Strong forbidden transitions, especially ΔM/sub Br/ = +- 2 transitions are observed and it has been possible to determine the relative signs of the principal components of the α-bromine hyperfine A and quadrupole Q tensors. Analysis shows that these signs are different from those previously assumed. The principal values obtained were equal to A+108, +39, +22(plus-or-minus)=7 G, and Q-13, +18, -5(plus-or-minus)=2 G for ^{81}Br and A196, 20, 0G for ^{19}F. The nature of the chemical bond and the geometry of the radical have been deduced from these tensors.

27570 Radiation-hardenable diluents for radiation-hardenable compositions. Schuster, K.E.; Rosenkranz, H.J.; Furh, K.; Ruedolph, H. (to Bayer Aktiengesellschaft). US Patent 4,180,474. 25 Dec 1979. Priority date 11 Nov 1976, German, Federal Republic of (F.R. Germany), 10p.

Radiation-crosslinkable diluents for radiation-hardenable compositions (binders) consisting of a mixture of triacrylates of a reaction product of trimethylol propane and ethylene oxide with an average degree of ethoxylation of from 2.5 to 4 are described. The ethoxylated trimethylol propane is substantially free from trimethylol propane and has the following distribution: 4 to 5% by weight of monoethoxylation product, 14 to 16% by weight of diethoxylation product, 20 to 30% by weight of triethoxylation product, 20 to 30% by weight of tetraethoxylation product, 16 to 18% by weight of pentaethoxylation product, and 6 to 8% by weight of hexaethoxylation product. The diluents effectively reduce the viscosity of radiation-hardenable compositions and do not have any adverse effect upon their reactivity or upon the properties of the resulting hardened products.

27571 Uniformly irradiated polymer film. Fowler, S.L. (to W.R. Grace and Co.). US Patent 4,178,220. 11 Dec 1979. Filed date 4 Apr 1977. 4p.

Irradiated film having substantial uniformity in the radiation dosage profile is produced by irradiating the film within a trough having lateral deflection blocks disposed adjacent the film edges for deflecting electrons toward the surface of the trough bottom for further deflecting the electrons toward the film edge.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

HOT-ATOM CHEMISTRY

27572 (DOE/ER/02190—1) Dynamics and mechanisms of hot chemistry stimulated by recoil methods. Progress report, 1 March 1979-29 February 1980. Spicer, L.D. (Utah Univ., Salt Lake City (USA)). Nov 1979. Contract AS02-76ER02190. 16p. NTIS, PC A02/MF A01.

The secondary excitation function for production of cyclobutane-t from the hot hydrogen replacement reaction with cyclobutane was estimated and reported. Using a stepladder model the average stepsizes for cascade deactivation by several bath gases have been determined. Further progress on the interpretation of the dynamics which follow hot chlorine replacement reactions in small ring compounds has also been made. A new silylation reaction with sulfur dixoide was discovered. The process involves the direct attack of hexamethyldisilazane on sulfur dioxide leading eventually to 1,1,1-Trimethyl-N-sulfinyl silanamine.

27573 Mechanisms of the chlorine-38 for chlorine substitution in dichlorobenzene in the condensed phase. Berei, K.; Ache, H.J. (Virginia Polytechnic Inst. and State Univ., Blacksburg). *J. Phys. Chem.;* **84**: No. 7, 687-691(3 Apr 1980).

The ^{38}Cl-for-Cl or -H substitution following the $^{37}Cl(n,\gamma)^{38}Cl$ nuclear reaction was studied in neat liquid dichlorobenzene isomers with and without I_2 present as radical scavenger as well as in highly diluted mixtures of these compounds with a variety of organic solvents, such as simple aliphatic hydrocarbons, aromatics, and perfluorinated aliphatics and aromatics. The results obtained in these systems suggest an interaction between the molecules making up the solvent cage with the intermediates forming the substituted product. This interaction consists most likely of a H abstraction by the Cl radical in the solvent cage, which competes with the reactions of thermal Cl leading to the ^{38}Cl-substitution products, resulting in reduced yields of the latter compound. In the cases of unreactive wall molecules, e.g., perfluorinated hydrocarbons, such a reaction cannot take place, and the yields of the ^{38}Cl-substitution products remain large. When the hot ^{38}Cl-for-Cl substitution in solid dichlorobenzenes present in different crystal forms was studied, no effect of the crystal structure on the substitution process was observed.

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 26959, 27697

27574 (CONF-800542—2) Decontamination of large horizontal concrete surfaces outdoors. Barbier, M.M.; Chester, C.V. (Barbier (Marcel M.) Scientific Consulting, Herndon, VA (USA); Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 28p. NTIS, PC A03/MF A01.

From Concrete decontamination workshop; Seattle, WA, USA (28 May 1980).

Portions of document are illegible.

A study is being conducted of the resources and planning that would be required to clean up an extensive contamination of the outdoor environment. As part of this study, an assessment of the fleet of machines needed for decontaminating large outdoor surfaces of horizontal concrete will be attempted. The operations required are described. The performance of applicable existing equipment is analyzed in terms of area cleaned per unit time, and the comprehensive cost of decontamination per unit area is derived. Shielded

equipment for measuring directional radiation and continuously monitoring decontamination work are described. Shielding of drivers' cabs and remote control vehicles is addressed.

27575 (LA-UR—80-1460) **Decontamination of concrete surfaces at the Los Alamos Scientific Laboratory.** Cox, E.J.; Garde, R. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 17p. (CONF-800542—3). NTIS, PC A02/MF A01.

From Concrete decontamination workshop; Seattle, WA, USA (28 May 1980).

For the past two years the Los Alamos Scientific Laboratory has been engaged in decontaminating its former plutonium facility. The facility was in use for over 30 years for plutonium operations varying from dry metallurgical processes to wet (solution) recovery processes. To date approximately 3400 square meters of floor surface have been decontaminated to permit re-use for nonplutonium work. Approximately 330 square meters of concrete surfaces required scarifying the contamination after all other attempts such as detergents and acid solutions had proven ineffective. The uses of hand-held and floor type pneumatic scarifiers are described as well as an inexpensive but effective contamination containment chamber built at Los Alamos for use with the hand-held model. Contamination control, waste handling, manpower requirements, and cost are documented for the techniques used at LASL.

27576 (PNL—3300(Pt.1), pp 143-144) **Dissolution of LMFBR fuel-sodium aerosols.** Briant, J.K.; Allen, M.D.; Moss, O.R. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Aerosols of either LMFBR fuel or PuO_2 are essentially insoluble in water or biological fluids. If either of these aerosols is exposed to sodium metal vapor, the resulting aerosol is much more soluble in aqueous solutions. Preferential dissolution of uranium from mixed sodium-fuel aerosols makes the plutonium more readily soluble than for sodium-PuO_2 aerosol. Ultrafiltration of the dissolution test solvent revealed the plutonium to be associated with particles between 2 nm and 10 nm in diameter, in both cases.

27577 (RHO-SA—167) **Soil surface decontamination and revegetation progress.** Graves, A.W. (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). Dec 1979. Contract AC06-77RL01030. 15p. (CONF-791234—5). NTIS, PC A02/MF A01.

From Environmental decontamination workshop; Oak Ridge, TN, USA (4 Dec 1979).

The type of work at Rockwell Hanford Operations (Rockwell) related to large-area decontamination efforts is discussed. A Program Office manages the decontamination and decommissioning (D and D) efforts. Part of the program is involved with large-surface area cleanup in conjunction with surveillance and maintenance of retired sites and facilities. The other part is the decontamination and decommissioning of structures. The large-surface area cleanup work is described in this presentation.

27578 (RHO-SA—168) **Project planning approach.** Toomey, J.E. (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). Dec 1979. Contract AC06-77RL01030. 13p. (CONF-791234—4). NTIS, PC A02/MF A01.

From Environmental decontamination workshop; Oak Ridge, TN, USA (4 Dec 1979).

This paper will discuss the project planning approach utilized by Rockwell Hanford Operations in outdoor cleanup activities. The discussion will address the rationale and requirements as well as description of the planning documents. In addition, a recommended adaptation of this approach to a large scale environmental cleanup process is included. The three major elements of Rockwell Hanford's project planning approach are assignment of responsibilities, development of applicable criteria, and alternatives identification, assessment and recommendation. Data gathering and data management are also necessary elements to complete the planning. The specific planning documents that are used at Rockwell Hanford are described. The documents are divided into two major areas: control plans and project plans.

27579 **Kinetic study of the oxidation of a series of N-alkylphenothiazines by neptunium(VI) in aqueous perchlorate media.** Pelizzetti, E.; Woods, M.; Sullivan, J.C. (Argonne National Lab., IL). *Inorg. Chem.;* **19**: No. 2, 524-527(Feb 1980).

The kinetics of oxidation of a series of N-alkylphenothiazines to the corresponding cation radicals by means of neptunium(VI) have been studied by a stopped-flow spectrophotometric technique. The reaction rates are first order in both of the reagents and are independent of acidity. A linear relation between ΔG° and $\Delta G^{\ddagger}$ for the title series of reactions is observed. Values of the rate parameters calculated from the Marcus theory are about 100 times greater than the experimental values. There is also a marked discrepancy between experimental and calculated values of $\Delta H^{\ddagger}$ and $\Delta S^{\ddagger}$. 1 figure, 6 tables.

COMBUSTION, PYROLYSIS, AND HIGH-TEMPERATURE CHEMISTRY

27580 (SAND—80-8713) **Imaging of a conserved scalar in gas mixing by means of a linear spark.** Schmieder, R.W.; Kerstein, A. (Sandia Labs., Livermore, CA (USA)). Jun 1980. Contract AC04-76DP00789. 19p. NTIS, PC A02/MF A01.

A straight filamentary spark produced by a laser has been used to image the spatial distribution of gases in a jet of methane in air. The technique provides a direct map of a conserved scalar quantity useful in modeling turbulent reacting flows, and may have other experimental advantages.

27581 **Flame advection and propagation algorithms.** Chorin, A.J. (Department of Mathematics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). W-7405-ENG-48. *J. Comput. Phys.;* **35**: No. 1, 1-11(15 Mar 1980).

We present a simple algorithm for approximating the motion of a thin flame front of arbitrary shape and variable connectivity, which is advected by a fluid and which moves with respect to the fluid in the direction of its own normal. As an application, we examine the wrinkling of a flame front by a periodic array of vortex structures.

ENGINEERING

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 26982, 27359

27582 (ANL-CT—80-18) **Tube vibration in industrial size test heat exchanger.** Halle, H.; Wambsganss, M.W. (Argonne National Lab., IL (USA)). Mar 1980. Contract W-31-109-ENG-38. 64p. NTIS, PC A04/MF A01.

Tube vibration data from tests of a specially built and instrumented, industrial-type, shell-and-tube heat exchanger are reported. The heat exchanger is nominally 0.6 m (2 ft) in dia and 3.7 m (12 ft) long. Both full tube and no-tubes-in-window bundles were tested for inlet/outlet nozzles of different sizes and with the tubes supported by seven, equally-spaced, single-segmental baffles. Prior to water flow testing, natural frequencies and damping of representative tubes were measured in air and water. Flow testing was accomplished by increasing the flow rates in stepwise fashion and also by sweeping through a selected range of flow rates. The primary variables measured and reported are tube accelerations and/or displacements and pressure drop through the bundle. Tests of the full tube bundle configuration revealed tube rattling to occur at intermediate flow rates, and fluidelastic instability, with resultant tube impacting, to occur when the flow rate exceeded a threshold level; principally, the four-span tubes were involved in the regions immediately adjacent to the baffle cut. For the range of flow rates tested, fluidelastic instability was not achieved in the no-tubes-in-window bundle; in this configuration the tubes are supported by all seven baffles and are, therefore, stiffer.

27583 (DOE/ER/0386—1) **Particle deposition in granular media. Annual progress report.** Tien, C. (Syracuse Univ., NY (USA). Dept. of Chemical Engineering and Materials Science). 1980. Contract AC02-79ER10386. 76p. NTIS, PC A05/MF A01.

Studies performed under Contract DE-AC02-79-ER10386.A000 Particle Deposition in Granular Media during the period June 1, 1979 to date are described. These studies include the design and construction of apparatus for filtration experiments and a complete trajectory analysis for the calculation of the initial collection efficiency of granular media. The results of the trajectory analysis have been used to develop a generalized correlation of the collection efficiency.

27584 (DOE/ET/13151—T5) **Active feedback control for stabilization of vibration in rotating machinery (24.034). Period covered: April 1-June 30, 1980.** (Virginia Univ., Charlottesville (USA). Dept. of Mechanical and Aerospace Engineering). 1980. Contract AC01-79ET13151. 15p. NTIS, PC A02/MF A01.

Some of the considerations involved in the use of feedback control as a means of reducing the unbalanced response of a rotor or of eliminating or alleviating rotor dynamic instability are discussed. A simple model of a mass on a flexible shaft is used to illustrate the application of feedback control concepts. A description is given of a system assembled at the University of Virginia which uses feedback control individually adjustable in the vertical and horizontal directions to support the shaft bearings.

27585 (K/TS—3798) **Approximation of finite element nodal point stresses for nonlinear material models.** Bass, B.R.; Johnson,

W.G.; McGrath, S.V. (Oak Ridge National Lab., TN (USA)). 28 Feb 1980. Contract W-7405-ENG-26. 44p. NTIS, PC A03/MF A01.

A computational scheme is described for approximating elastic-plastic stress components at the nodal points of finite element grids. The method is based on a local least squares smoothing technique and a well-known incremental plasticity model. During each load step of the materially nonlinear analysis, strain values at the Gauss integration points are extrapolated to the nodes; the incremental change in strains at the nodes is then determined from previously stored nodal strain values. The increment in nodal stresses is calculated from the incremental elastic-plastic stress-strain relations for the nodes and added to the nodal stresses computed in the previous update. An application of the scheme to the analysis of a thin bellows under compressive loading is discussed; the results are compared with those obtained from using a different nodal stress technique.

27586 (UCRL—52928-79) **Mechanical engineering research program reports for Fiscal Year 1979.** Feng, W.W.; Simecka, W.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Mar 1980. Contract W-7405-ENG-48. 9p. NTIS, PC A02/MF A01.

This document lists the formal reports published by the Mechanical Engineering Research (MER) Program for Fiscal Year 1979. The MER mission is to develop key technologies required by the Nuclear Explosives Program to meet its intermediate and long-range objectives. In the report, which summarizes the accomplishments on projects conducted under the MER Program during 1979, titles are given first followed by abstracts in some cases.

27587 **Dynamics of flexible cylinders in axisymmetrically confined axial flow.** Paidoussis, M.P. (McGill Univ., Montreal, Quebec); Pettigrew, M.J. *J. Appl. Mech.;* **46**: No. 1, 37-44(Mar 1979).

Experiments are described in which flexible cylinders placed centrally within a narrow cylindrical flow channel were subjected to axial flow. The dynamic behavior of such cylinders, either cantilevered or supported at both ends, is described, both in liquid and in simulated two-phase flows; the effect of several parameters, such as the annular confinement, was investigated. It was observed that, with increasing flow, the cylinder is subject sequentially to instabilities of increasing mode number, confinement severely destabilizing the system. The experimental observations are compared to a theoretical model for the dynamics of such systems. In the case of liquid flow, agreement is qualitatively good and quantitatively fair - keeping in mind the experimental difficulties. In the case of two-phase flows, theory and experiment do not agree.

27588 **Heat pipes.** Dunn, P.; Reay, D.A. New York, NY; Pergamon Press, Ltd. (1978). 344p. (CONF-760313—(Ed.2)).

From 2. international conference on heat transfer; Bologna, Italy (31 Mar 1976).

This volume updates a 1975 edition on the theory and performance of many forms of heat pipes and contains an appendix of papers selected from the 2nd International Heat Pipe Conference held in 1976. Information is included on the history, theory, design, fabrication, working fluids, materials, performance and uses of heat pipes. (LCL)

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 27217, 28201

27589 (LA-UR—80-1566) **Magnetic refrigeration for space applications.** Barclay, J.A.; Steyert, W.A. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 6p. (CONF-800631—7). NTIS, PC A02/MF A01.

From 8. international cryogenic engineering conference; Genoa, Italy (3 Jun 1980).

Magnetic refrigeration is briefly analyzed and thermodynamically compared to gas refrigeration. The characteristics of magnetic refrigerators with respect to spacecraft applications are discussed and indicate that high reliability coupled with high efficiency is possible. The latest experimental results on several wheel and reciprocating magnetic refrigerators are summarized.

27590 (NBS—80-01) **Superconducting devices and materials. A literature survey issued quarterly, January-March 1980.** Olien, N.A. (comp.). (National Bureau of Standards, Boulder, CO (USA). Thermophysical Properties Div.). 1980. 149p. National Bureau of Standards, Cryogenic Data Center, Boulder, CO.

An extensive bibliography, i.e., over 200 pages of articles from 18 US and foreign journals, on superconducting devices and materials is presented. An author index is included. Upcoming conferences related to cryogenic research are listed. (LCL)

27591 **Temperature dependence of the minimum in AC power losses of (Nb/sub 0.99/Zr/sub 0.01/)$_3$Sn in parallel AC and DC magnetic fields.** Kovachev, V.T. (Brookhaven National Laboratory, Associated Universities Inc., Upton, New York 11973). *J. Appl. Phys.;* **51**: No. 7, 3812-3815(Jul 1980).

ac losses P/sub L/ of bronze-processed (Nb/sub 0.99/Zr/sub 0.01/)$_3$Sn strips have been measured between 4.2 and 16.5 K in the presence of a dc magnetic field H_e. The measurements were performed using an electronic wattmeter with both ac and dc fields parallel to the long flat surfaces of the sample. A minimum in the function P/sub L/(H_e) was observed for fixed ac amplitudes h_e. This minimum was found to occur in the entire temperature range between 4.2 and 16.5 K. A similar minimum was recently reported in Nb_3Ge [Thompson et al., J. Appl. Phys. 50, 3514 (1979)] at 4.2 K. The position of the minimum is explained here by the same physical model as in Thompson et al. [J. Appl. Phys. 50, 3514 (1979)]; and Clem (ibid. 3518), but extending the model to include the temperature dependence of the entry surface shielding fields $\Delta H/sub en/(B,T)$ for flux density in the sample B=0. It is also shown here that loss minimum measurements can be used for the determination of $\Delta H/sub en/(0,T)$ in the temperature range 4.2—16.5 K.

27592 **System for the measurement of fast response times under fast electromagnetic irradiation.** Schuller, I. (Univ. of California, Los Angeles); Clark, M.; Berman, J.; Gray, K.E. *J. Phys., E (London);* **12**: 263-265(1979).

A system that has been used successfully for the measurement of relaxation time of superconducting tunnel junctions under light irradiation is described. The system allows the measurement of 2 μV signals of less than 10 ns rise time, with a signal-to-noise ratio of better than 4. We also describe, for the first time, the behaviour of a commerical GaAs solid state laser at cryogenic temperatures.

HANDLING EQUIPMENT AND PROCEDURES

27593 (ORNL/CSD/TM—115) **Surface density representation of critical configurations of U(5)O_2 planar and linear arrays.** Maudlin, P.J.; Thomas, J.T. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7504-ENG-36. 29p. NTIS, PC A03/MF A01.

A criticality data base for planar and linear arrays of low enriched damp uranium dioxide powder contained in cylindrical units is generated with the Monte Carlo criticality program KENO-IV. This information is correlated with the Limiting Surface Density model, $\sigma(m) = c_2(m_0-m)$, refining the bulky KENO data base into a simple table of correlation constants c_2 and m_0. A solid angle representation of the KENO data base is provided. The solid angles were analytically determined by the SNAKE code and these are compared to an approximate formulation of the total solid angle associated with a critical array.

SHIPPING CONTAINERS

REFER ALSO TO CITATION(S) 26963

27594 (LA—8366-MS) **Hypothetical accident conditions, free drop and thermal tests: Specification 6M.** Blankenship, R.W. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 15p. NTIS, PC A02/MF A01.

The 30 gallon Specification 6M shipping container with rolled-top food pack cans as inner containers is evaluated under conditions required by 10 CFR 71.42. One kilogram of depleted uranium as UO_2 was packaged in each of the inner containers. After completion of a free drop test and a simulated thermal test, the maximum observed leakage of UO_2 for the following week was 3.2 μg. This leakage is well below the allowable leakage per week for most plutonium isotopic mixtures. Using the examples provided, any plutonium isotopic mixture can be easily compared with the allowable leakage per week. Test conditions and results are reported.

27595 (LA—8367-MS) **Hypothetical accident conditions free drop and thermal tests USA/5791/BLF (ERDA-AL).** Blankenship, R.W. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 17p. NTIS, PC A02/MF A01.

The USA/5791/BLF (ERDA-AL) shipping container with rolled-top food pack cans as inner containers is evaluated under conditions required by 10 CFR 71.42. One kilogram of depleted uranium as UO_2 was packaged in each of the inner containers. After completion of a free drop test and a simulated thermal test, the maximum observed leakage of UO_2 for the following week was 3.0 μg. This leakage is well below the allowable leakage per week for most plutonium isotopic mixtures. Using the examples provided, any plutonium isotopic mixture can be easily compared with the allowable leakage per week. Test conditions and results are reported.

MINING AND DRILLING EQUIPMENT AND FACILITIES

REFER ALSO TO CITATION(S) 26812, 26814, 26815

LASERS

REFER ALSO TO CITATION(S) 28220

27596 (DOE/DP/40103—4) **Rare gas halide lasers for fusion. Final technical report, 1 March 1979-29 February 1980.** Duzy, C.; Hsia, J.; Hyman, H.; Jacob, J.; Klimek, D.; Parks, J.; Trainor, D. (Avco-Everett Research Lab., Everett, MA (USA)). Apr 1980. Contract AC08-79DP40103. 106p. NTIS, PC A06/MF A01.

In an effort to reliably extend the understanding of KrF* lasers, we collected specific, detailed experimental data and carried out theoretical calculations to explore and document those issues we identified as likely to be important in the short pulse operating regime. These included the effects of: (1) fuel burnup, (2) electron quenching, (3) gain/absorption at high current densities, (4) photoionization, (5) accessibility of the lying levels of KrF by laser flux, (6) temperature on fluorescence efficiency.

27597 (LA-UR—80-1480) **Retraining of technicians in Laser/electro-optics technology.** Morrison, R.E. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 7p. (CONF-800646—1). NTIS, PC A02/MF A01.

From International laser/electro-optics training conference; Wausau, WI, USA (Jun 1980).

The need for trained personnel to work in the Laser/electro-optics field, and the training of such technicians either as new young workers or as retrained older employees are discussed. (LCL)

27598 (SAND—79-2480) **Laser development for laser fusion applications. Research progress report, October 1978-September 1979.** (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 162p. NTIS, PC A08/MF A01.

During this report period, emphasis has been directed toward the advanced development of the HF, KrF, Se(^{1}S)-Se(^{3}P), and the chemically pumped iodine laser systems.

27599 (UCRL—83649) **Thermal characteristics of discharge-heated copper vapor laser (DHCVL) heat shields formed of multiple coaxial cylinders.** Alger, T.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Jan 1980. Contract W-7405-ENG-48. 8p. (CONF-800723—6). NTIS, PC A02/MF A01.

From 19. national heat transfer conference; Orlando, FL, USA (27 Jul 1980).

A calculational method for predicting the axial temperature variation of each cylinder of a finite length heat shield formed of multiple coaxial cylinders was developed for longitudinal discharge, discharge-heated copper vapor laser (DHCVL) application. This model includes diffuse-gray thermal radiation and axial conduction effects, but it neglects radial conduction and convection. Example calculations for three different possible DHCVL geometries (diameters) are presented to demonstrate the importance of emissivity, number of included cylinders and the applied heat flux on the plasma tube maximum temperature and the axial temperature profile. Comparison is made between a predicted and a measured DHCVL maximum plasma tube temperature.

27600 **Regenerative compression of laser pulses.** Murray, J.E.; Kuizenga, D.J. (Lawrence Livermore Laboratory, University of California, P.O. Box 5508, Livermore, California 94550). W-7405-ENG-48. *Appl. Phys. Lett.;* **37**: No. 1, 27-30(1 Jul 1980).

We report stable temporal compression of mode-locked laser pulses using a saturable dye in a regenerative amplifier. We have demonstrated compression at 1.06 μm from 120 to 15 ps with energy stability better than +- 5%, and we have demonstrated synchronization of the compressed pulse to pulses as long as 1000 ps.

27601 **ND : YAG regenerative amplifier.** Murray, J.E.; Lowdermilk, W.H. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). W-7405-ENG-48. *J. Appl. Phys.;* **51**: No. 7, 3548-3556(Jul 1980).

The Nd : YAG regenerative amplifier produces short-duration, optical pulses with the stability and pulse width range characteristic of actively mode-locked lasers and the pulse energy characteristic of passively mode-locked lasers. Other important properties, including large amplification and optical pulse storage, have also been achieved.

27602 **Saturation of absorption in p-Ge using picosecond CO_2 laser pulses.** Kwok, H.S. (Gordon McKay Laboratory, Harvard University, Cambridge, Massachusetts 02138). W-7405-ENG-48. *J. Appl. Phys.;* **51**: No. 7, 3837-3840(Jul 1980).

A time-resolved measurement on the recovery of saturation in p-Ge was performed with picosecond CO_2 laser pulses. It was directly confirmed that the relaxation of hole excitation in p-Ge was faster than 40 psec and that this type of measurement can provide additional temporal information on picosecond pulses.

27603 **Optical analysis of laser systems using interferometry.** Viswanathan, V.K.; Liberman, I.; Lawrence, G.; Seery, B.D. (University of California, Los Alamos Scientific Laboratory, P.O. Box 1663, Los Alamos, New Mexico 87545). *Appl. Opt.;* **19**: No. 11, 1870-1873(1 Jun 1980).

Previous methods of predicting focal spot parameters such as the Strehl ratio and encircled energy of large laser systems like the Los Alamos fusion CO_2 lasers involved the digitization of interference patterns of the optical components and propagation of the complex amplitude and phase of the wave front throughout the system. In the new approach described in this paper, the computational procedure has been extended to produce computer plots of the final emerging wave front. this enables direct comparison with the experimentally produced wave front of the total system and opens the way for optical analysis, design, and possible optimization of laser systems, especially CO_2 laser systems. The computational procedure and the Twyman-Green and Smartt IR interferometers constructed to verity this approach are described. The implications of the results are discussed.

27604 **Copper vapor laser unstable resonator oscillator and oscillator-amplifier characteristics.** Hargrove, R.S.; Grove, R.; Kan, T. (Univ of Calif, Lawrence Livermore Lab). *IEEE J. Quant. Electron.;* **QE-15**: No. 11, 1228-1233(Nov 1979).

A study was made of the properties of copper vapor lasers configured as oscillators with unstable resonator optics and as power amplifiers. With the unstable resonator, a 26-fold reduction in the oscillator beam divergence has been achieved over the value observed with stable optics without any power degradation. Time-dependent beam divergence effects in the unstable resonator have also been measured and explained. Small-signal gain, saturation fluence, and available stored energy density parameters have also been measured in oscillator amplifier experiments for both the 510.6 and 578.2 nm transitions as a function of the copper number density. These results quantify the maximum power per unit length avaialble from these devices and furthermore demonstrate efficient extraction of power from copper vapor lasers operated as amplifiers. 17 refs.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 27353, 27587

27605 **Low Peclet number heat transfer for power law non-Newtonian fluid with heat generation.** Dang, V.D. (Brookhaven National Lab., Upton, NY). *J. Appl. Polym. Sci.;* **23**: 3077-3103(1979).

Heat transfer for power law non-Newtonian fluid with heat generation and axial conduction is analyzed. Radial and axial temperature distribution and the Nusselt number inside a tube are obtained in terms of nonorthogonal series expansion. Eigenvalues and eigenfunctions are given for different values of various parameters. The effects of Peclet number, power law model index, viscous dissipation, and heat generation on the temperature distribution and Nusselt number are discussed. Comparison of the present results for extreme cases with those obtained by previous workers shows good agreement.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 27251, 27515

27606 (SAND—80-1301C) **Technique for the generation of pressure-shear loading using anisotropic crystals.** Swegle, J.W.; Chhabildas, L.C. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 15p. (CONF-800641—2). NTIS, PC A02/MF A01.

From International conference on the metallurgical effects of high strain rate deformation and fabrication; Albuquerque, NM, USA (22 Jun 1980).

In this investigation, Y-cut quartz crystals are used as pressure-shear generators, and X-cut quartz and 6061-T6 aluminum are used as test specimens. The coupled longitudinal and shear motion generated within the Y-cut crystal can be transmitted into a test specimen bonded to the rear surface of the crystal, and monitored using velocity interferometer techniques. Experiments on X-cut quartz and 6061-T6 aluminum demonstrate applicability of the technique. Results obtained in this investigation are compared with numerical solutions obtained using the finite difference wave propagation code TOODY.

SAFETY ENGINEERING

REFER ALSO TO CITATION(S) 27987

ELECTRONIC CIRCUITS AND DEVICES

27607 (GEPP-TIS—495) **Stress analysis of glass-ceramic insulator and molybdenum cylinders in vacuum tube subassembly.** Spears, R.K. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 10 Jun 1980. Contract AC04-76DP00656. 32p. NTIS, PC A03/MF A01.

This study determined the state of stress between molybdenum cylinders and a glass-ceramic insulator of a vacuum tube during cooling when the glass-ceramic coefficient of expansion differed from molybdenum by $+\text{-}2 \times 10^{-7}$/°C. A thermoelastic stress analysis was performed on the vacuum tube subassembly using the finite element method. Two cases, which examined the effect of cooling over a 700°C range, were considered. In Case One, the expansion coefficient of the glass-ceramic was 2×10^{-7}/°C less than that of molybdenum while for Case Two, it was 2×10^{-7}/°C greater. For Case One, it was found that the tangential stresses in the insulator were entirely compressive but the maximum principal stresses in the r-z plane were mainly tensile. For Case Two, the tangential stresses were tensile in the insulator as were most of the maximum principal stresses in the r-z plane except for stress in the upper regions of the insulator. The magnitude of the stress at the maximum principal stress location appears to be substantially lower than what has been observed in practice (i.e., cracking of this design had never been a major problem, but it has been observed that if the coefficient of expansion of the glass-ceramic was 2×10^{-7}/°C lower than molybdenum, cracking usually resulted). This analysis showed that the expansion coefficient of the glass-ceramic could be varied quite liberally from molybdenum before the ultimate strength (13,000 lb/in.^{2}) of the glass-ceramic was exceeded.

27608 (ORNL/SUB—01617/15) **Development program for a 200 kW, CW 28 GHz gyroklystron. Quarterly report No. 15, October-December 1979.** Jory, H.; Conner, C.; Evans, S.; Moran, J.; Sayer, W.; Symons, R.; Thomas, G. (Varian Associates, Palo Alto, CA (USA). Palo Alto Microwave Tube Div.). 1979. Contract W-7405-ENG-26. 25p. NTIS, PC A02/MF A01.

The objective of this program is to develop a microwave oscillator capable of producing 200 kW of CW power at a frequency of 28 GHz. In addition, it is intended that the program will serve as the first step toward development of a device to produce a similar power level at a frequency of 60 and 110 GHz. Feasibility for the 60 and 110 GHz designs will be demonstrated, whenever practical, in the design of the 28 GHz device. Tunability or bandwidth is not considered an important parameter in the design, but efficiency is. Mode purity in the output waveguide is not a requirement for the device, but the circular TE mode is considered desirable because of its low loss properties. With these objectives in mind, the decision was made to pursue an approach based on a cyclotron resonance interaction between an electron beam and microwave fields. The detailed arguments leading to this choice are contained in the final report of the preceding study program. The device configuration of particular interest, called a gyrotron, has been discussed in recent literature. It typically employs a hollow electron beam interacting with cylindrical resonators of the TE/sub 0ml/ class.

27609 (SAND—80-0333C) **Upset and latchup thresholds in CD-4000 series CMOS devices. IRT 4337-007.** Harrity, J.W.; Gammill, P.E. (IRT Corp., San Diego, CA (USA); Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 10p. (CONF-800703—4). NTIS, PC A02/MF A01.

From Annual conference on nuclear and space radiation effects; Ithaca, NY, USA (15 Jul 1980).

A test program designed to verify that neutron irradiation and subsequent anneal is an effective method for suppressing ionization-induced latchup yielded as a byproduct a large body of data covering the upset and latchup thresholds of non-neutron-irradiated bulk CMOS devices. Sixty-six part types in the hardened RCA CD-4000 series and four National Semiconductor part types were tested. Upset levels ranged from 2-200 rad(Si). Latchup was observed in forty of the seventy part types tested. Latchup thresholds ranged from 9 to 708 rad(Si). Latchup currents ranged from 15 mA to 1.9 A.

27610 (SAND—80-0506C) **X-ray triggered switching in SF_6 insulated spark gaps.** Neau, E.L. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 4p. (CONF-800640—13). NTIS, PC A02/MF A01.

From 14. pulse power modulator symposium; Orlando, FL, USA (3 Jun 1980).

Several methods are being investigated for triggering low-jitter pressurized, SF_6-insulated spark gaps operating at 3 MV with the capability of switching hundreds of kiloamperes. One method, which is located external to the main current carrying plasma channel, uses pulsed x-rays to generate ionization within the working gas volume to initiate low jitter gas breakdown. In this paper, a model of gas breakdown with x-ray ionization is developed and results of two series of experiments are described. One experiment used 35 kV with a 1.83 mm gap and the other used 1 MV with a 7.62 cm gap. Both experiments used a 600 kV Febetron 706 flash x-ray source to demonstrate the feasibility of using pulsed x-rays as a means of triggering SF_6 insulated gaps with nanosecond jitter.

27611 (SAND—80-0810) **Computer control and data management in an LSI fabrication facility.** Doyal, L.A.; Weaver, D.L.; Gwyn, C.W. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 25p. NTIS, PC A02/MF A01.

A minicomputer system is used to control diffusion furnaces, monitor temperatures, provide operator instructions for each processing step, and record detailed process histories for wafer lots fabricated in the Sandia Semiconductor Development Laboratory. The system provides a complete data base for laboratory operations, a variety of displays describing equipment status, scheduling and utilization summaries for equipment, wafer and mask inventories, and laboratory management information. The wafer lot history includes a record indicating the operator, time, date, and specification recipe for each process step, special notes summarizing process deviations, results of inspection steps, and in-line capacitance, oxide thickness, or resistivity measurements.

27612 (SAND—80-0844C) **Latch-up elimination in bulk CMOS LSI circuits.** Schroeder, J.E. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 6p. (CONF-800703—3). NTIS, PC A02/MF A01.

From Annual conference on nuclear and space radiation effects; Ithaca, NY, USA (15 Jul 1980).

Recent data on latch-up prevention in CMOS LSI circuits by the use of epitaxial starting material are presented, a modification of the lumped transistor SCR model is discussed, and a useful graphical solution to the latch-up problem is described.

27613 (SAND—80-1290C) **Fiber optic communication links.** Meyer, R.H. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 20p. (CONF-800574—1). NTIS, PC A02/MF A01.

From IMOG meeting held on subgroup environmental testing; Albuquerque, NM, USA (20 May 1980).

Fiber optics is a new, emerging technology which offers relief from many of the problems which limited past communications links. Its inherent noise immunity and high bandwidth open the door for new designs with greater capabilities. Being a new technology, certain problems can be encountered in specifying and installing a fiber optic link. A general fiber optic system is discussed with emphasis on the advantages and disadvantages. It is not intended to be technical in nature, but a general discussion. Finally, a general purpose prototype Sandia communications link is presented.

27614 **High voltage SCR trigger circuit utilizing disc capacitors in a Marx array.** Jacoby, B.A.; York, T.M. (Pennsylvania State University, University Park, Pennsylvania 16802). EY-76-S-02-4020. *Rev. Sci. Instrum.;* **51**: No. 7, 885-886(Jul 1980).

An SCR Marx circuit which is characterized as inexpensive and reliable, with no warm-up or heater power has been constructed, tested, and utilized in a pulsed discharge experiment. The specific circuit design produced an output pulse of 13 kV with a risetime of 0.12 μs and a FWHM of 0.16 μs. With a 500 V self-enclosed battery power supply, the pulse generator was insensitive to triggering by stray signals, with an observed jitter of +- 50 ns in triggering a spark gap of 18 kV.

27615 **Controllability/observability analysis of digital circuits.** Goldstein, L.H. (Sandia Labs., Albuquerque, NM). *IEEE Trans. Circuits Syst.;* **26**: No. 9, 685-693(Sep 1979).

The testability of a digital circuit is directly related to the difficulty of controlling and observing the logical values of internal nodes from circuit inputs and outputs, respectively. A method for analyzing digital circuits in terms of six functions which characterize combinational and sequential controllability and observability is presented.

WASTE PROCESSING PLANTS AND EQUIPMENT

REFER ALSO TO CITATION(S) 27367

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 26763, 26822, 27201, 27313, 27348, 27352

27616 (ANL/EES-TM—85) **Pulse combustion technology for heating applications. Quarterly progress report, January 1-March 31, 1980.** Blomquist, C.A.; Clinch, J.M.; Ahrens, F.W. (Argonne National Lab., IL (USA)). Apr 1980. Contract W-31-109-ENG-38. 28p. NTIS, PC A03/MF A01.

The primary purpose of the research program described in this progress report is to develop and expand the technology base for fossil-fuel-fired pulse combustion heating systems. A major goal of the program is to develop design data and design procedures for pulse combustion burners. This design capability will contribute to the accelerated industrial development of cost-effective, high-efficiency systems for a variety of heating applications.

27617 (CONF-800428—6) **Heat exchanger materials for fluidized bed coal combustors.** Godfrey, T.G.; Copper, R.H.; DeVan, J.H.; Drake, K.R. (Oak Ridge National Lab., TN (USA); FluiDyne Engineering Corp., Minneapolis, MN (USA)). 1980. Contract W-7405-ENG-26. 13p. NTIS, PC A02/MF A01.

From 6. international conference on fluidized bed combustion; Atlanta, GA, USA (9 Apr 1980).

The 4500-h test in the FluiDyne AFBC tells us three things: (1) ferritic and austenitic superheater alloys perform well to approximately 590°C (1100°F), (2) high-temperature alloys can perform well at approximately 870°C (1600°F), and (3) they also may fail miserably at approximately 870°C (1600°F). Additional studies are clearly needed to develop a fundamental understanding of corrosion mechanisms in AFBC and to determine the envelope of safe operating conditions, which will depend upon alloy sensitivity, the oxygen and sulfur activities, and the many parameters that affect mixing and homogeneity within an operating AFBC. Ultimately long-term tests for periods to 20,000 h will be needed to assure the operability of in-bed heat exchanger and structural materials for the anticipated lifetime of a plant. Good design and well-controlled operations will yield good material performance in AFBC. The key to reliable material usage is operation within the safe envelope. Results from the present experiment suggest that this envelope is large for utility steam systems but smaller for high-temperature tubes and uncooled components in AFBC.

27618 (CONF-7906157—, pp 1-6) **Department of Energy overview.** Freedman, S.I. Apr 1980.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

Pressurized fluidized bed combustion (PFBC) is a more advanced concept incorporating the advantages of AFBC, but with the increased conversion efficiency obtained by cascading power cycles over sequential temperature ranges. The PFBC combined cycle concept is based upon utilizing a coal-fired gas turbine topping-steam turbine bottoming cycle, which can achieve heat rates 10 to 20 percent better than conventional coal-fired steam power systems. Other important attributes of PFBC are reduced boiler tube surface (compact combustion space, reduced costs), efficient operation at low temperatures (reduced NO/sub x/ emissions), no slag formation on boiler tube surfaces (increased boiler reliability), capability of using coals of all ranks (as well as other fuel materials) and capability of meeting all applicable emission standards (gaseous, particulate, thermal). PFBC economics are also attractive, with first generation PFBC power plants potentially being able to achieve as much as ten percent energy cost savings over conventional coal-fired plants with stack gas cleaning. Because of the particular configuration of the PFBC system, PFBC technology is expected to find its widest application in the electric power generation market (electric utilities, with a smaller degree of industrial use).

27619 (CONF-7906157—, pp 7-14) **Overview of the EPRI PFBC program.** Slaughter, W.W. (Electric Power Research Inst., Palo Alto, CA). Apr 1980.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

PFBC offers several advantages for baseload power generation. The fluidized bed, with limestone or dolomite addition, permits direct combustion of high sulfur coal without the need for flue gas desulfurization to meet 90+ % reductions in SO_2 emissions. NO/sub x/ emissions are substantially lower in the FBC boiler than in conventional plants, and are reduced further with increases in combustor pressure. Operation of the combustor at pressure also allows for very compact combustor designs. Also, the combined cycle configuration with potential overall plant efficiencies of 40%, will become more attractive as fuel prices continue to escalate. A major decision currently being considered by EPRI staff is the necessity for additional test facilities for PFBC development in addition to those currently operating or under construction. The need is apparent for a process development facility to support the following requirements for utility application of the PFBC concept: (1) verify operating parameters currently being considered by the three units presently planned for large scale demonstration (high pressure, steam tube), (2) allow simulation of problems expected and encountered in the larger demonstration units, (3) develop control algorithms for the PFBC process, (4) provide materials verification and testing, and (5) serve as a focus for US development of the PFBC technology.

27620 (CONF-7906157—, pp 71-88) **IEA Overview. Part I. Design and construction of the Grimethorpe Experimental Facility.** Kaden, M.; Smith, D. (National Coal Board, Ltd., London, England). Apr 1980.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

The agreement to build a large pressurized fluidized bed combustion experimental facility was reached in December 1975 between the Governments of the United States of America, the United Kingdom and the Federal Republic of Germany under the auspices of the International Energy Agency. The function of the facility would be to extend the range of fluidization and combustion characteristics investigated from those of the realtively small rigs then in operation across the whole range of conditions potentially applicable to combined cycle power generation systems. The main problems have been in converting the ad hoc procedures of the small experimental rigs into fully engineered systems involving a scale up of some 10:1. The ultimate aim would be to seek an optimum condition and establish a data base from which a demonstration plant could be designed and built. All design work is now complete, erection of the plant on site is well advanced. All main civil works are complete, erection of all main supporting steelwork is complete. The turbo-compressor has been erected, alighted, cold commissioned and is ready for hot commissioning. The main pressure vessels, combustor and heat exchanger, have been erected and installation of the steam/water pipework between them is well advanced. Erection of the high temperature/high pressure ductwork for the gas path is in progress. The pressure vessels for the fuel pressurization and injection system are in the course of erection. The fuel preparation plant is in course of erection and the installation of mechanical equipment in the concerete tanks of the water treatment and recovery system has commenced.

27621 (CONF-7906157—, pp 170-185) **Miniplant PFBC studies.** Hoke, R.C.; Ruth, L.A.; Ernst, M.; Nutkis, M.S.; Garabrant, A.R.; Goodwin, J.L.; Radovsky, I.B. (Exxon Research and Engineering Co., Linden, NJ). Apr 1980.

From Pressurized fluidized bed combustion technology exchange workshop; Secaucus, NJ, USA (5 Jun 1979).

Recent studies in the pressurized fluidized bed combustion facilities at Exxon Research and Engineering Company have been concerned with: demonstration of the proposed new source performance standards (NSPS) for SO_2 emission control (85% reduction) and NO/sub x/ emission control (0.6 lb/MBtu); evaluation of NO/sub x/ emission reduction methods such as staged combustion, NH_3 injection, and simulated flue gas recirculation; evaluation of high temperature/pressure particulate control devices such as cyclones and a ceramic fiber filter, and low temperature/pressure devices such as an electrostatic precipitator and a bag house; evaluation of gas turbine and heat exchanger materials in extended tests; and evaluation of sorbent regeneration. The program is sponsosred by the US Environmental Protection Agency and the US Department of Energy.

27622 (GA-A—15901) **Selecting fines recycle methods to optimize fluid bed combustor performance.** Rickman, W.S.; Fields, D.E.; Brimhall, W.L.; Callahan, S.F. (General Atomic Co., San Diego, CA (USA)). May 1980. Contract AT03-76SF71053. 7p. NTIS, PC A02/MF A01.

Testing and analysis of a number of different fines recycle methods for fluid bed combustors has led to a generalized modeling technique. This model accounts for the effect of pertinent variables in determining overall combustion efficiencies. Computer application of this model has allowed trade-off studies to be performed that show the overall process effects of changes in individual operating parameters. Verification of the model has been accomplished in processing campaigns while combusting fuels such as graphite and bituminous coal. A 0.4 MW test unit was used for the graphite experimental work. Solid fuel was typically crushed to 5 mm maximum screen size. Bed temperatures were normally controlled at 900°C; the combustor was an atmospheric unit with maximum in-bed pressures of 0.2 atm. Expanded bed depths ranged from 1.5 to 3 meters. Additional data was taken from recycle tests sponsored by EPRI on the B and W 6 ft x 6 ft fluid bed combustor. These tests used high sulfur coal in a 1.2 meter deep, 850°C atmospheric fluidized bed of limestone, with low recycle rates and temperatures. Close agreement between the model and test data has been noted, with combustion efficiency predictions matching experimental results within 1%.

27623 (ORNL/MIT—303) **Reaction modeling of an atmospheric fluidized-bed coal combustor.** Sood, J.S.; Fok, S.K.; Friedman, J.H. (Oak Ridge National Lab., TN (USA); Massachusetts Inst. of Tech., Oak Ridge, TN (USA). School of Chemical Engineering Practice). Jun 1980. Contract W-7405-ENG-26. 55p. NTIS, PC A04/MF A01.

A model of an atmospheric fluidized-bed combustor of coal was developed to account for combustion in both the bubbling-bed and freeboard regions. The bubbling bed was modeled by the method of Louis and Tung, while the freeboard model assumed undispersed gas and solid phases. Comparison of feed, bed, and elutriant particle-size distributions obtained from the model indicated

realistic qualitative predictions. Parametric sensitivity analyses with respect to bed temperature, superficial velocity, and coal feed rate indicated physically realistic trends. Inclusion of the free-board region slightly increased predicted combustion efficiencies but led to values which exceeded those reported from the Babcock and Wilcox facility. On the other hand, the model underpredicted those values when the freeboard was excluded. The main weakness of the present model results from dependent inputs which must be calculated a priori to maintain consistency.

MARINE ENGINEERING

REFER ALSO TO CITATION(S) 27144

STIRLING

REFER ALSO TO CITATION(S) 27408, 27409, 27410, 27411, 27412, 27413, 27414, 27415, 27416, 27417

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

REFER ALSO TO CITATION(S) 28215

27624 **Needs versus means in high-energy physics.** Panofsky, W.K.H. (Stanford Linear Accelerator Center). *Phys. Today;* **33**: No. 6, 24-33(Jun 1980).

To maintain the steady increase in collision energy achieved during the last fifty years, after the lifespan of currently planned accelerators and storage rings, will take new, still conjectural, ideas.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

REFER ALSO TO CITATION(S) 28013

AUXILIARIES AND COMPONENTS

REFER ALSO TO CITATION(S) 28242

27625 **Radiological environmental impact of high-energy accelerators.** Thomas, R.H. (Univ. of California, Berkeley); Rindi, A. *CRC Crit. Rev. Environ. Control;* 51-95(Feb 1979).

A discussion of the radiological hazards of high-energy particle accelerators is presented. These include exposure to prompt radiation while the accelerator is in operation as well as radionuclide release to the environment due to such things as soil activation by radiation around the accelerator tunnel. (GHT)

ION SOURCES

27626 **Recent developments in high charge state heavy ion beams at the LBL 88-inch cyclotron.** Gough, R.A.; Clark, D.J.; Glasgow, L.R. *IEEE Trans. Nucl. Sci.;* **NS-26**: No. 2, 2164-2166(Apr 1979).

Recent advances in design and operation of the internal PIG sources at the LBL 88-Inch Cyclotron have led to the development of high charge state ($0.4 \leqq Q/A \leqq 0.5$) heavy ion beams between lithium and neon with energies $20 \leqq E/A/ \leqq 32$ MeV per nucleon, including fully stripped ions up to $^{16}O^{8+}$. Total external intensities of these beams range from 10^{12} particles/s for $^{6}Li^{3+}$ to 0.1 particles/s for $^{16}O^{8+}$. Techniques have been developed for routine tune-out of the low intensity beams. These include use of model beams and reliance on the large systematic data base of cyclotron parameters which has been developed over many years of operation. Techniques for delivery of these weak beams to the experimental target areas are presented. Source design and operation, including special problems associated with Li, Be and B beams, are discussed.

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 27640

27627 (BNL—27206) **Cryogenic distribution system for the first cell.** Brown, D.P.; Schneider, W.J. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 15p. (CONF-800804—6). NTIS, PC A02/MF A01.

From ASME century 2 emerging technology conference; San Francisco, CA, USA (10 Aug 1980).

The ISABELLE refrigeration system utilizes compressed liquid helium to supply refrigeration to nearly 1100 superconducting bending and focusing magnets. These magnets steer the proton orbits of the accelerator and are arranged into two interlocking rings. The cryogenic distribution system that is used to transmit the helium cooling from the central refrigerator to the superconducting magnets makes up a substantial portion (34%) of the total heat load that the refrigerator must be capable of supplying. This piping system has been designed to minimize the heat input into the refrigeration system. The design and test results of the distribution system in use on the ISABELLE prototype, the first cell are described.

27628 (COO—3130-4) **Muon spin polarization measurements using Cerenkov radiation.** Dichter, B. (Brown Univ., Providence, RI (USA). Dept. of Physics). Jun 1979. Contract AC02-76ER03130. 30p. NTIS, PC A03/MF A01.

A summary is presented of the experimental development and testing of a muon polarimeter, a device to be used in an experiment proposed for the PEP facility. The work consisted of two phases. Phase one was the cosmic ray studies, done at Brown University during the summer of 1978, using a small model of the actual polarimeter. A second series of tests, done on a much more sophisticated version of the polarimeter, was conducted at the Brookhaven AGS A2 test beam. A discussion of the polarimeter concept and a brief description of some of the hardware used in the experimental work are given. Results of the summer tests are discussed, and theoretical calculations of the quantities of interest in the Brookhaven tests are presented. (GHT)

27629 (LA—8350-PR) **Accelerator technology program. Progress report, April-December 1978.** Knapp, E.A.; Jameson, R.A. (comps.). (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-48. 208p. NTIS, PC A10/MF A01.

This report presents highlights of activities in the Acceleartor Technology (AT) Division from April through December 1978. The report is divided into 10 sections to cover work done by the four groups that make up AT Division (AT-1, AT-2, AT-3, and AT-4). Section I is a brief summary of the whole report. Sections II through VI describe work done by At-1, the Linac Technology Group. Subjects covered are the Pion Generation for Medical Irradiation Program, the Electronuclear Fuel-Producing Accelerator Program, the Gyrocon rf Amplifier Program, the Electron Linear Accelerator Program, and the Free Electron Laser Program. Section VII covers the Linear Accelerator Beam Dynamics development, and Sec. VIII deals with work with the H^- Ion Source. Most of the work in Secs. VII and VIII was done by AT-2, the Special Projects Group, although work on factors influencing emittance growth was done by MP-9, and results on emittance growth in the new European Council for Nuclear Research (CERN) linac were reported by an AT-DO/MP-9 team. Section IX concerns the Proton Storage Ring Program for which AT-3, the Storage Ring Technology Group, is responsible. Section X describes the Fusion Materials Irradiation Test (FMIT) Program. This work is done by AT-4, which was organized in April 1978 to design and supervise the construction of the FMIT accelerator. The accelerator team is composed of personnel from AT-4 and the Hanford Engineering Development Laboratory, Richland, Washington. This report covers the activities of the integrated team. This report covers the activities for the last 9 months of 1978.

27630 (ORNL/SUB—33200/2) **Development program for a 200 kW, CW gyrotron. Quarterly report No. 2, October-December 1979.** Arnold, K.W.; Tancredi, J.J.; Caplan, M.; Ha, K.W.; Birnbaum, D.N.; Weiss, W. (Hughes Aircraft Co., Torrance, CA (USA). Electron Dynamics Div.). 1979. Contract W-7405-ENG-26. 37p. NTIS, PC A03/MF A01.

The objective of this program was the design and development of a millimeter-wave device to produce 200 kW of continuous-wave power at 110 GHz. The device, which will be a gyrotron oscillator, will be compatible with power delivery to an electron-cyclotron plasma. Smooth control of rf power output over a 17 dB range is required, and the device should be capable of operation into a severe time-varying rf load mismatch. During the middle of this report period, the operating frequency was changed to 60 GHz.

27631 (SAND—80-0476C) **Terawatt power division and combination using self-magnetically insulated transmission lines.** Crow, J.T.; Peterson, G.D. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 6p. (CONF-800640—11). NTIS, PC A02/MF A01.

From 14. pulse power modulator symposium; Orlando, FL, USA (3 Jun 1980).

Self-magnctically insulated transmission lines are necessary for the efficient transport of the terawatt pulses used in electron and ion accelerators. For some applications it is desirable to divide one transmission line into two, or to combine outputs of two or more lines into one, by means of self-magnetically insulated convolutes. Tests have been made on a coaxial-to-triaxial convolute in which

connections between negative inner and outer lines are made by pins passing through holes in the intermediate positive conductor. Measurements in the 2 MV, 400 kA, 40 ns pulse Mite facility indicate virtually 100% current transport through the convolute and the ability to vary the division of current between the inner and outer lines of the triax by choice of inner line impedance. These measurements, and results obtained with this convolute connected to the ion diode for which it was designed, will be presented.

27632 Proposed computing facilities for Triangle Universities Nuclear Laboratory. Gould, C.R. (North Carolina State Univ., Raleigh); Roberson, N.R.; Edwards, S.E.; Jensen, M.; Wender, S.A. *IEEE Trans. Nucl. Sci.;* **NS-26**: No. 4, 4373-4377(Aug 1979).

The current computing facilities at TUNL have been in operation for 14 years. Design considerations for a new computer system, to be installed and operational by mid 1980, are discussed. The new large-memory, 32-bit minicomputers appear to provide the most cost-effective way of handling the data acquisition and analysis needs of a medium-sized nuclear physics laboratory. 7 figures.

STORAGE RINGS

REFER ALSO TO CITATION(S) 27624

27633 (LA-UR—80-1510) **Fast-extraction modulators for Los Alamos Scientific LaboratorY Proton Storage Ring.** Nunnally, W.C.; Hudgings, D.W.; Sarjeant, W.J. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 6p. (CONF-800640—10). NTIS, PC A02/MF A01.

From 14. pulse power modulator symposium; Orlando, FL, USA (3 Jun 1980).

The development of a short-bunch mode fast-extraction modulator for the LASL proton storage ring has made necessary the design and development of a resonant transformer charging circuit and the design of a new FIB line circuit to provide bipolar pulse outputs with low prepulse, postpulse, and an optimum high-voltage switch environments. The systems are now being developed to operate reliably at the high-average powers required. The short-bunch mode fast-extraction modulator prototype is presently operating. The initial construction of the long-bunch mode fast-extraction modulator prototype is under way, with results expected within the year.

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

27634 (LBL—10548) **Reliability considerations of electronics components for the deep underwater muon and neutrino detection system.** Leskovar, B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1980. Contract W-7405-ENG-48. 20p. (CONF-800240—1). NTIS, PC A02/MF A01.

From Deep underwater muon and neutrino detection signal processing workshop; Honolulu, HI, USA (11 Feb 1980).

The reliability of some electronics components for the Deep Underwater Muon and Neutrino Detection (DUMAND) System is discussed. An introductory overview of engineering concepts and technique for reliability assessment is given. Component reliability is discussed in the contest of major factors causing failures, particularly with respect to physical and chemical causes, process technology and testing, and screening procedures. Failure rates are presented for discrete devices and for integrated circuits as well as for basic electronics components. Furthermore, the military reliability specifications and standards for semiconductor devices are reviewed.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

REFER ALSO TO CITATION(S) 27462

27635 (UCRL—83808) **Development of a temporally and spatially resolved grazing incidence spectrometer.** Dietrich, D.D.; Fortner, R.J.; Price, D.F.; Stewart, R.E.; Gilman, C.; Helava, H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 13p. (CONF-800320—5). NTIS, PC A02/MF A01.

From 3. topical conference on high temperature plasma diagnostics; Los Angeles, CA, USA (17 Mar 1980).

The design considerations are presented for a grazing incidence spectrometer which will resolve both temporally and spatially the emission from a wide variety of plasmas. The basis of the design involves use of microchannel plates (MCPs) which are curved to conform to the Rowland circle of the spectrometer. The spectra are obtained when the anode is properly biased. The use of multiple anodes allows gating and with appropriate delays results in sequential time resolution of a few nanoseconds. Simultaneous gating of the anodes with spatial resolution of $< 100\mu$ for any given time frame can also be obtained. The efficiency of this spectrometer is also compared with conventional grazing incidence spectrometers.

27636 ANNPEAK: a program for lineshape analysis of Doppler broadening of positron annihilation photons. Kelly, J.J.; Lambrecht, R.M. (Brookhaven National Lab., Upton, NY). *Adv. Chem. Ser.;* No. 175, 271-278(1979).

A flexible program for the lineshape analysis of Doppler broadened spectra of positron annihilation photons was developed to calculate the lineshape parameters Q, W, L, fwhm, μ, and σ_2/sup M/ from a normalized annihilation spectrum. An improved linear selection method was used to limit lineshape dependence on the background correction. This program was used to analyze the Doppler-broadened annihilation spectra obtained with a spectrometer using two-point digital stabilization. Nuclear lines of ^{133}Ba and ^{207}Bi were used for energy calibration purposes. The program described has convenient options for optimization and output of data. 3 figures.

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 27628

27637 (BNL—27758) **Plane grating monochromators for synchrotron radiation.** Howells, M.R. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract AC02-76CH00016. 36p. (CONF-791176—4). NTIS, PC A03/MF A01.

From Japan-USA seminar on synchrotron radiation facilities; Honolulu, HI, USA (5 Nov 1979).

The general background and theoretical basis of plane grating monochromators (PGM's) is reviewed and the particular case of grazing incidence PGM's suitable for use with synchrotron radiation is considered in detail. The theory of reflection filtering is described and the problem of the finite source distance is shown to be of special importance with high brightness storage rings. The design philosophy of previous instruments is discussed and a new scheme proposed, aimed at dealing with the problem of the finite source distance. This scheme, involving a parabolic collimating mirror fabricated by diamond turning, is considered in the context of Wolter-type telescopes and microscopes. Some practical details concerning an instrument presently under construction using the new design are presented.

27638 (BNL—27844) **Evaluation of focusing monochromators for an EXAFS spectrometer.** Heald, S.M. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 9p. (CONF-800487—1). NTIS, PC A02/MF A01.

From Workshop on laboratory EXAFS sources; Seattle, WA, USA (28 Apr 1980).

Various focusing monochromators are compared and evaluated for use in an EXAFS spectrometer. For a line focus the Johann and Johansson case are found to be most suitable. Obtaining a point focus is more difficult, with the best case appearing to be a singly bent mirror used in conjunction with the Johann or Johansson crystals.

27639 (CONF-800452—2) **Spin spectrometer at the holified heavy-ion research facility and some planned experiments.** Sarantites, D.G.; Jaaskelainen, M.; Hood, J.T.; Woodward, R.; Barker, J.H.; Hensley, D.C.; Halbert, M.L.; Chan, Y.D. (Washington Univ., St. Louis, MO (USA). Dept. of Chemistry; Saint Louis Univ., MO (USA). Dept. of Physics; Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 13p. NTIS, PC A02/MF A01.

From International conference on nuclear behavior at high angular momentum; Strassbourg, France (22 Apr 1980).

The 4π multidetector γ-ray spectrometer at the Holified Heavy-ion Research Facility (HHIRF) is described in some detail. The following important features of this spectrometer are discussed: (a) the geometric arrangement, (b) the actual performance of the individual detector elements, (c) the associated electronics and data acquisition system, and (d) the response of the system to input γ-cascades including the effect of crystal-to-crystal scattering and the response to neutrons. The first few experiments to be performed are briefly described.

27640 (ORNL/TM—7276) **Multispecimen dual-beam irradiation damage chamber.** Packan, N.H.; Buhl, R.A. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 38p. NTIS, PC A03/MF A01.

An irradiation damage chamber that can be used to rapidly simulate fast neutron damage in fission or fusion materials has been designed and constructed. The chamber operates in conjunction

with dual Van de Graaff accelerators at ORNL to simulate a wide range of irradiation conditions, including pulsed irradiation. Up to six experiments, each with up to nine 3-mm disk specimens, can be loaded into the ultrahigh vacuum chamber. Specimen holders are heated with individual electron guns, and the temperature of each specimen can be monitored during bombardment by an infrared pyrometer. Three different dose levels may be obtained during any single bombardment, and the heavy-ion flux on each of the nine specimens can be measured independently with only a brief interruption of the beam. The chamber has been in service for nearly three years, during which time approximately 250 bombardments have been successfully carried out. An appendix contains detailed procedures for operating the chamber.

27641 CRISIS detector. Wadsworth, B.F.; Barreiro, F.; Goloskie, D.A. (Massachuestts Inst. of Tech., Cambridge). *IEEE Trans. Nucl. Sci.;* **NS-26**: No. 1, 120-128(Feb 1979).

The prototype of a charged-particle identifier with 1m x 1m acceptance was tested at Fermilab by use of a pion-proton beam at 40 and 100 GeV/c. Its operation is based on the principle of ionization sampling, and the test results indicate that the prototype achieved the 14% fwhm resolution predicted for the distribution of average ionization for 64 samples taken in an 80% Ar - 20% CO_2 gas mixture. Dependence of the performance on various parameters is discussed. 12 figures.

27642 (ANL/AMD/TM—24) **ANL bubble chamber and spark chamber data handling system.** Butler, J.; Hodges, D. (Argonne National Lab., IL (USA)). [nd]. Contract W-31-109-ENG-38. 18p. NTIS, PC A02/MF A01.

A data handling and interpretation system is described which is capable of dealing with the large flow of information from a bubble chamber. Total information from the data is estimated to be 1,000,000 bits/sec, or about 3 x 10^{13} bits/year. (FS)

27643 (ANL/AMD/TM—35) **CHLOE: a system for the automatic handling of spark pictures.** Butler, J.W.; Hodges, D.; Royston, R. (Argonne National Lab., IL (USA)). [nd]. Contract W-31-109-ENG-38. 17p. NTIS, PC A02/MF A01.

The system for automatic data handling uses commercially available or state-of-the-art components. The system is flexible enough to accept information from various types of experiments involving photographic data acquisition. (FS)

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 26768, 26783, 26785, 26788, 26952, 27484, 27523, 27530, 27632

27644 (BNL—27899) **Effective mass trigger at the Brookhaven Multi-Particle Spectrometer (MPS).** Willen, E.H. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 23p. (CONF-800243—1). NTIS, PC A02/MF A01.

From Wire chamber conference; Vienna, Austria (27 Feb 1980).

An effective mass trigger for use at the Brookhaven Multiparticle Spectrometer (MPS) is described. It is a microprocessor based device using extensive fast memory attached to proportional wire chambers in the MPS magnetic field. It will select kinematic quantities unique to the reaction being studied, thereby permitting higher sensitivities and a reduction in data-processing cost for MPS experiments. The principles of operation for this trigger, and the results of simulations to assess its performance, are presented.

27645 (DOE/ER/10474—1) **Improvement of reliability of welding by in-process sensing and control: development of smart welding machines for girth welding of pipes. First progress report.** Converti, J.; Dror, Y.; Hardt, D.E.; Masubuchi, K.; Paynter, H.M.; Unkel, W.C. (Massachusetts Inst. of Tech., Cambridge (USA). School of Engineering). 30 Nov 1979. Contract AC02-79ER10474. 42p. NTIS, PC A03/MF A01.

Progress is reported in a research program to improve the reliability of welding by developing smart welding machine which will be equipped with sensors, artificial intelligence, and actuators for reducing welding errors by one or two orders of magnitude. (FS)

27646 (LBL—10136) **Displacement sensors and actuators needed to control a segmented primary mirror.** Gabor, G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1980. Contract W-7405-ENG-48. 24p. (CONF-800116—2). NTIS, PC A02/MF A01.

From Optical and infrared program conference; Tucson, AZ, USA (7 Jan 1980).

A segmented primary mirror control system was developed for use in the proposed University of California ten meter optical telescope. The general design goals for a displacement sensor and position actuator are listed. A sensor and actuator which were built are described with some test results. A brief senario is given of how these two units would be incorporated into a primary mirror.

27647 Ultrasensitive detection of aromatic hydrocarbons by two-photon photoionization. Klimcak, C.; Wessel, J. (Ivan A. Getting Laboratories, The Aerospace Corporation, Los Angeles, California 90009). 79EV10239.000. *Appl. Phys. Lett.;* **37**: No. 2, 138-141(15 Jul 1980).

An optimized multiphoton photoionization detection system has been applied to monitor aromatic-hydrocarbon vapor density as a function of temperature. The density curves established for naphthalene by this procedure permit estimation of a detection limit of 5 x 10^4 molecules/cm^3 in a nitrogen buffer gas. With slight modification this method woud be capable of single-molecule detection limits.

27648 Procedure for loading diamond cells with high-pressure gas. Mills, R.L.; Liebenberg, D.H.: Bronson, J.C.; Schmidt, L.C. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). W-7405-ENG. 36. *Rev. Sci. Instrum.;* **51**: No. 7, 891-895(Jul 198C).

We devised an apparatus and technique for loading diamond-anvil cells with gases at high pressure. Cells were filled quickly and conveniently at room temperature with helium and hydrogen isotopes to initial densities exceeding those of the normal liquids. We report preliminary values of ^4He and D_2 melting points based on the ruby pressure scale and compare them with extrapolations from our earlier melting curves measured to 20 kbar in a piston-cylinder device. Our filling procedure now makes it possible to use ^4He as a pressure medium in diamond cells. The technique is also useful for loading cells with gaseous mixtures.

27649 Fast high-resolution ion energy and momentum spectrometer. Krishnan, M.; Hirshfield, J.L. (Department of Engineering and Applied Science, Mason Laboratory, Yale University, New Haven, Connecticut 06520). EG-77-S-4363. *Rev. Sci. Instrum.;* **51**: No. 7, 911-917(Jul 1980).

A novel energy/momentum spectrometer consisting of a multigrid ion energy analyzer in tandem with an inflexion focusing magnetic sector momentum analyzer is described. The entire analyzer ion flight path may be negatively biased relative to the outer (grounded) instrument housing to enable post acceleration (up to a few keV) of grid extracted ions from laser blow-off plasmas or laser-initiated vacuum arcs. Used as a time-of-flight momentum spectrometer, the instrument is shown capable of unraveling velocity distributions and relative abundances of ions of different charge in expanding laser blow-off plasmas, even for a few keV initial ion energy spread. Used as a discharge ion analyzer, the high mass resolution of the instrument, ($m/\Delta m = 110$), enables ion isotopic species of carbon, iron and copper to be readily separated and energy analyzed. A channeltron collector provides wide dynamic range ($\sim 10^8$) and high time resolution (~ 1.0 μs), enabling detection of low abundance species such as polymer ions in carbon discharges.

27650 Design and performance of presently available tv-rate stereo SEM systems. Pawley, J.B. (Univ. of California, Berkeley). *Scanning Electron Microsc.;* **1**: 157-166(1978).

This paper reviews the operating principles and performance of TV stereo SEM systems introduced by Electron Technology, Cambridge-Imanco, Coates and Welter Instruments, and Japan Electron Optics. Differences in design and operation of deflection and display systems are reviewed and tabulated. A standard test sample permitting easy determination of stereo tilt and comparative spatial resolution was observed with each system. Dynamic results from the viewing screen at 10kV, +- 2 1/2° tilt, 5kX, are shown for comparison purposes, and they show rough equivalence of performance between the systems when some consideration is made for differences in the various SEM's to which the stereo systems were fitted. Results using the normal slow-scan record system in conjection with electromagnetic tilt show that excellent images can be obtained at 20kV, +-5°, 5kX, if limitations of signal/noise and electronic deflection switching glitches are not present, and the system is limited only by the electron optical aberrations in the deflection system.

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 26944

EXPLOSIONS AND EXPLOSIVES

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

27651 (DOE/EV/06194—T1) **High explosive safety manual. Final technical report, September 1978-May 1980.** Albaugh, L.R.; McBride, D.A. (Hercules, Inc., Cumberland, MD (USA). Hercules Aerospace Div.). Jun 1980. Contract AC01-78EV06194. 127p. NTIS, PC A07/MF A01.

A Safety Manual for High Explosive Processing, Handling, and Testing has been prepared for the Department of Energy. Background on the preparation and recommendations for manual implementation and augmentation are provided. The Manual is provided as a separate document.

27652 (LA—8204-MS) **Developmental studies of constitutive models for plastic-bonded explosives.** Hackett, R.M.; Peeters, R.L.; Oakes, W.R. Jr. (Los Alamos Scientific Lab., NM (USA)). Jun 1980. Contract W-7405-ENG-36. 12p. NTIS, PC A02/MF A01.

Typically, elastic and elastic-plastic theory are used in structural analysis computer programs to model the mechanical behavior of high explosives; these models, however, do not fit the observed behavior of plastic-bonded explosives. The development of an equation-of-state creep model and a linear viscoelastic model for the analysis of these material systems is discussed and comparisons between experimental results and analytical model predictions are shown.

27653 (LA—8327-MS) **Numerical and theoretical analysis of some spherically symmetric containment vessel problems.** Slaughter, M.D. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 20p. NTIS, PC A02/MF A01.

A numerical analysis of some spherically symmetric containment vessel problems is accomplished using the one-dimensional hydrodynamics code SIN. The typical problem involves a spherical steel vessel containing a detonating spherical charge of PBX-9404 at its center, with a mitigator (air or vermiculite) surrounding the charge. Two different vessels are considered - one having 17.6-cm inner radius and 0.635-cm-thick shell and the other having an 88.9-cm inner radius and a 6.35-cm-thick shell. Three different charge masses are used: 15.82 g, 8.17 kg, and 27.24 kg. In each configuration considered, the displacement of the shells and the pressure in the air at the inner wall are obtained as a function of time. The results agree well with experimental data. A simple theoretical model is also considered and gives solutions in reasonable agreement with the numerical results.

27654 (LA—8352-MS) **Premature detonation problem.** Pimbley, G.H.; Marshall, E.F. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 76p. NTIS, PC A05/MF A01.

Determining how cavities or voids in the explosive loads of artillery shells cause in-bore premature detonations is important to military authorities. Though answers continue to be elusive, in detailing recent studies of the problem at LASL, some traditional approaches were examined and a new direction of investigation is suggested. The aquarium experiment and the pipe test were devised at LASL to model the events taking place in a base gap, or in an internal cavity, in the load of an accelerating artillery shell. Numerical simulation was used to assess the data from these experiments. Both the experimental and the numerical simulation phases of the project are described. The commonly accepted gas compression, thermal ignition mechanism is not consistent with the results of this study. The dominant mechanism or mechanisms have not been identified.

27655 (LA-UR—80-1282) **Studies of fast reactions in detonations.** Mader, C.L. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 13p. (CONF-800714—1). NTIS, PC A02/MF A01.

From NATO advanced study institute on fast reactions in energetic systems; Ioannina, Greece (6 Jul 1980).

The time-dependent behavior of the flow in reaction zones of the detonating homogeneous explosives nitromethane, liquid TNT, and ideal gases has been investigated using one- and two-dimensional Lagrangian and Eulerian numerical hydrodynamics with Arrhenius chemical reaction. A general model for bulk decomposition of heterogeneous explosives, called Forest Fire, has been developed, which gives the rate of explosive decomposition as a function of local pressure. The model permits description of the process of heterogeneous explosive initiation, propagation, and failure.

27656 (MHSMP—80-06(Rev.)) **Characterization of the NOL small scale gap test as performed at Pantex Plant.** West, G.T.; Demerson, E.L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Jun 1980. Contract AC04-76-DP00487. 24p. NTIS, PC A02/MF A01.

The NOL Small Scale Gap Test as performed at Pantex was characterized by determining transit times of the RP-2 detonator, the RDX donor, the plexiglas attenuator (six thicknesses were tested) and HNS acceptors of varying type and density. Pressures in the plexiglas attenuators at the output surface were also obtained. The planarity of the emerging shock wave at the RDX and the attenuator output surfaces was also measured. Two types of HNS were tested in the normal gap test procedure, each at two different densities.

27657 (MHSMP—80-10) **Self-luminous event photography with the Marco M-4 image converter camera system.** Meyer, T.O. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Feb 1980. Contract AC04-76DP00487. 20p. NTIS, PC A02/MF A01.

The camera system is shown to be applicable to selfluminous events, such as the flasher-gap-enhanced shock waves which are depicted. Successive photographs of the detonation wavefront progressing across disc of high explosive (PBX 9404) are used for the determination of detonation velocity. Time intervals between film exposures for the four individual camera heads are easily measured and may extend from a few nanoseconds to ten milliseconds.

27658 (MHSMP—80-20) **Tool force evaluation of lathe machined high explosives.** Flowers, G.L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Apr 1980. Contract AC04-76DP00487. 44p. NTIS, PC A03/MF A01.

The purpose of this study was to develop a better understanding of the effects of machining properties upon tool forces encountered during lathe machining of high explosives, in order to optimize machining conditions for mechanical properties test specimens. Monetary considerations dictated that the tooling either already exist or be fabricated in-house using limited machine shop capability. The design chosen which fit between the tool holder and the tool post and interfaced to existing signal conditioners was easily fabricated. The study evaluated all forces on the cutter during machining of two types of high explosives at four cutter radii, four feed rates, three depths of cut and two cutting speeds. The study pointed out design problems, instrumentation drift, tool chatter and detection levels. It also showed that the type of high explosive was more significant than first thought toward influencing tool force levels.

27659 (MHSMP—80-26) **Study of the compaction process for TATB formulations. Process development endeavor No. 209.** Harrell, J.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). May 1980. Contract AC04-76DP00487. 11p. NTIS, PC A02/MF A01.

Mathematical models were produced that will allow a reasonably close prediction of density for the formulations RX-03-DY, RX-03-DJ, RX-03-DI and RX-03-BB. RX-03-DI is more effectively compacted at pressures of 40 and 50,000 psi than the -DY and -DJ formulations; however, pressability is the same for the -DI, -DJ and -DY at pressures of 30,000 psi or less.

27660 (MHSMP—80-28) **Electrostatic sensitivity of secondary high explosives.** Campos, C.A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Jun 1980. Contract AC04-76-DP00789. 14p. NTIS, PC A02/MF A01.

An Electrostatic Sensitivity Test System designed at Pantex was used to evaluate the secondary high explosives PETN, HMX, RDX, HNS I, HNS II and TATB. The purpose of this study was to establish test conditions for a standard electrostatic sensitivity test and measure baseline data of a few secondary explosives. Although secondary explosives are often considered quite insensitive to an electrostatic discharge, PETN, HMX, and RDX were initiated. Several external elements to the high explosive were found to have an influence on sensitivity. Initiation appeared to be dependent on the nature of the discharge current curve. Those elements recognized as having a significant effect on the results were held constant in this study. These included: distance between discharge plates; sample moisture content; material density; and system resistance, capacitance and inductance. However, no attempt was made in this study to determine the extent to which the high explosive response to electrostatic discharge is affected by these factors since such correlation is not necessary to determine relative sensitivities.

27661 (UCRL—15240) **Characterization of initiation and detonation by Lagrange gage techniques. Final report.** Cowperthwaite, M.; Rosenberg, J.T. (SRI International, Menlo Park, CA (USA)). Apr 1980. Contract W-7405-ENG-48. 29p. NTIS, PC A03/MF A01.

SRI International performed theoretical studies on the Lagrange gage analysis techniques for determining flow fields and energy release rates in shocked explosives. Lagrange analyses were performed using as input the multiple Lagrange pressure histories recorded in shocked PBX 9404 at Lawrence Livermore Laboratory (LLL). The particle velocity histories calculated in these analyses were compared with those recorded in shocked PBX 9404 at LLL. The agreement between these calculated and measured particle velocity histories demonstrates the consistency of the stress and particle velocity measurements in shocked PBX 9404 and validates the use of both stress and particle velocity gages in the explosive

environment. A more realistic model was developed for describing a shocked reacting explosive and calculating the energy release rate from the flow parameters provided by a Lagrange analyses. The model is based on the assumption that the explosive and its reaction products attain mechanical equilibrium but have different temperatures. Equations expressing the first and second laws of thermodynamics for such a reacting explosive mixture were derived and interpreted physically to provide an understanding of the implicit assumptions made in formulating the constitutive relationships for calculating the reaction coordinate or reaction rate in the last step of a Lagrange analysis.

NUCLEAR

REFER ALSO TO CITATION(S) 27586

WEAPONRY

REFER ALSO TO CITATION(S) 27458

27662 (SAND—80-1268) **CM-458/U Signal Comparator.** Merritt, W.G.; Kestly, J.D. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 11p. NTIS, PC A02/MF A01.

The development history, the physical and functional characteristics, and the production activity of the CM-458/U Signal Comparator is described. The CM-458/U Signal Comparator is a test device used to verify proper delivery by the aircraft control equipment of the unique signal used in the prearming of modern nuclear weapons. CM-458/U monitors voltage levels, pulse widths and signal sequence to verify correctness.

27663 (UCID—18628) **Stemming and containment phenomenology for the Hybla Fair event.** Swift, R.P.; Burton, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Apr 1980. Contract W-7405-ENG-48. 37p. NTIS, PC A03/MF A01.

The Hybla Fair underground nuclear event was conducted by the Defense Nuclear Agency (DNA) to assess the feasibility of using low yield devices to reduce the expense of nuclear weapons effects testing. The economy of low yield tests was facilitated by placing of the test bed chamber closer to the source, thereby allowing the use of a shorter horizontal line-of-sight (HLOS) tunnel than used for higher yield testing. One main design concern for the Hybla Fair event centered around the desire for the radiation environment in the test chamber to be equivalent to that of higher yield tests. This concern imposed a severe constraint on the stemming column design. Studies of the required Hybla Fair stemming configuration, of the phenomenology of ground shock-induced stemming plug formation for low-yield events, of the effects of baffles on the stemming process, and of the integrity of the stemming closure region for the containment of the cavity gases are reported. (LCL)

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 27732, 27734, 27748, 27749, 27750, 27751

27664 (ATDL—79/16) **Environmental Research Laboratories, 1978 annual report.** (National Oceanic and Atmospheric Administration, Oak Ridge, TN (USA). Atmospheric Turbulence and Diffusion Lab.). Dec 1979. 348p. NTIS, PC A15/MF A01.

This report presents a compilation of research contributions from the Atmospheric Turbulence and Diffusion Laboratory of NOAA for 1978. Areas of research performed include: (1) the modeling of regional scale transport and diffusion; (2) energy effects on the atmosphere; (3) planetary boundary layer modeling; (4) transport modeling; (5) Lagrangian turbulence statistics; (6) statistical diffusion model; and (7) climatological studies. (ACR)

27665 (BNL—27801) **User's guide to the Heffter Interactive-Terminal Transport Model (ARL-HITTM).** Benkovitz, C.M.; Heffter, J.L. (Brookhaven National Lab., Upton, NY (USA)). Apr 1980. Contract AC02-76CH00016. 31p. NTIS, PC A03/MF A01.

The transport section of the Air Resources Laboratories (ARL) Atmospheric Transport and Dispersion Model (ATAD, Heffter, 1980) has been revised and simplified for use on interactive computer terminals. The resulting model, called the Heffter Interactive-Terminal Transport Model (ARL-HITTM) calculates four trajectories per day from one origin, forward or backward in time, using observed rawinsonde and pibal data for North America as input to the model. Trajectories, of three days duration, are based on observed winds averaged in a transport layer above terrain either chosen by the user or determined by the model.

27666 (COO—2195-35) **Further studies of the atmospheric temperature change produced by the Mt. Agung volcanic eruption in 1963.** Newell, R.E. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Meteorology). 26 Mar 1980. Contract AS02-76EV12195. 13p. (CONF-791231—2). NTIS, PC A02/MF A01.

From 17. General Assembly of the International Union of Geodesy and Geophysics; Canberra, Australia (Dec 1979).

The eruption of Mt. Agung in March 1963 introduced an aerosol layer into the stratosphere that was associated with stratospheric temperature increases of several degrees Kelvin. The mechanics of this temperature change in the tropical troposphere are examined by observations of its distribution in altitutde and time. (ACR)

27667 (ORNL/TM—7286) **Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1978-September 1979.** Patrinos, A.A.N.; Hoffman, H.W. (comps.). (Oak Ridge National Lab., TN (USA)). Apr 1980. Contract W-7405-ENG-26. 186p. NTIS, PC A09/MF A01.

The METER (Meteorological Effects of Thermal Energy Releases) Program was organized to develop and verify methods for predicting the maximum amount of energy that can be dissipated to the atmosphere (through cooling towers or cooling ponds) from proposed nuclear energy centers without affecting...the local and regional environment. The initial program scope (mathematical modeling, laboratory and field experimentation, and societal impact assessment) has now narrowed to emphasis on the acquisition of field data of substantial quality and extent.

27668 (ORNL/TM—7286, pp 59-82) **Field studies of cooling tower condensate scavenging.** Dana, M.T.; Glover, D.W. (Battelle, Pacific Northwest Labs., Richland, WA). Apr 1980.

In Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1978-September 1979.

Rainfall observations were made during six storms in the vicinity of the Bowen Generating Plant in March and April 1979; the aim was to detect any rainfall enhancement due to precipitation scavenging of cooling tower condensate and test the previously developed theory. Of six storms, three had the proper wind conditions for analysis, and of these, two were suitable for comparison of measurements with the theory. No obvious rainfall enhancement was observed, but the most favorable run for enhancement showed possible centerline enhancement not greater than ten percent. Due to the short duration of most of the rain events and poor time resolution on wind records, precise analysis of enhancement potentials was not possible.

27669 (ORNL/TM—7286, pp 83-100) **Sulfate aerosol production and growth in coal-operated power plant plumes.** Dittenhoefer, A.C.; de Pena, R.G. (Pennsylvania State Univ., University Park). Apr 1980.

In Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1978-September 1979.

The atmospheric oxidation rate of SO_2 to SO_4^{2-} particles in the plume of a large coal-burning power plant was studied over a wide range of meteorological conditions. Emphasis was focused on evaluating the importance of atmospheric relative humidity and solar radiative flux on plume sulfur chemistry in order to isolate and identify the principal chemical mechanisms. Measurements of particle production and growth were made within the plume of the coal-fired Keystone power plant using instrumented aircraft and applying a micro-chemical spot test for the quantitative identification of individual plume sulfate particles. An average gas-to-particle conversion rate of roughly 1%/h was found for thirteen flights conducted under widely varying meteorological conditions of relative humidity and solar radiative flux. A maximum rate of 6%/h was observed when the upper portion of the plume merged with a cloud desk, during which sulfate particles achieved their maximum size, due to droplet phase SO_2 oxidation. A noticeable change in the rate of conversion occurred at approximately 65% relative humidity, quite possibly the point of deliquescence of sulfate particles in the plume. Photochemistry alone did not account for much of the plume sulfur mass transformation for the flights studied but was primarily responsible for the production of high concentrations of small particles during conditions of high solar intensity and rapid plume dilution. There was some evidence that photochemical effects play a more significant role in plume chemistry at longer plume transport times. Conversion rates were highest and increased with plume age during conditions of high relative humidity and solar flux and intense atmospheric mixing for plumes embedded in air masses having high background Aitken particle concentrations. (JGB)

27670 (ORNL/TM—7286, pp 101-114) **Atmospheric measurement techniques for supplementary control system strategies.** Thomson, D.W.; Logan, M.J. (Pennsylvania State Univ., University Park). Apr 1980.

In Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1978-September 1979.

Successful application of the technique of switching from low-sulfur to high-sulfur coal fuel for power plants in response to changing atmospheric conditions, were it to be permitted by the Environmental Protection Agency, would depend upon the operation at the power plant of combined instrumentation and models which together are called a supplementary control system (SCS). The SCS is designed to insure that emissions from a given source will not cause the quality of the air around that source to deteriorate below the required standards during varying meteorological conditions. A computer-based measurement system that can solve most practical mixing layer diagnosis and prediction problems has been developed. This system is called the Computerized Acoustic Sounding System (CASS). CASS was successfully applied to the following special SCS problem: predictions of the time of fumigation (coincidence of the mixing layer depth and effective stack height) and the down-wind surface concentrations of SO_2 from a power plant. (JGB)

27671 (ORNL/TM—7286, pp 149-174) **Climatic probability of snowfall induced by cooling-tower plumes.** Murray, F.W. (Rand Corp., Santa Monica, CA). Apr 1980.

In Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1978-September 1979.

Several instances have been reported in which non-trivial amounts of snow were observed to fall from cooling-tower plumes when no natural snow occurred in the vicinity. In a previous study this phenomenon was examined both theoretically and empirically, and it was determined that such anomalous snowfall can be expected when the air temperature in the plume is colder than -13° and the difference between the saturation vapor density and the actual vapor density is less than 0.5 g m^{-3}. Since only air temperature and humidity are involved, it is feasible to examine the climatological records for a station to determine the frequency with which these conditions are normally fulfilled. For a pilot study the records for eleven stations distributed over the colder parts of the United States and encompassing the four coldest months over a period of eight years were collected. The conditions for anomalous snowfall were applied to this data base, and the probabilities for such snowfall were calculated by station and month. Predictably the probabilities were highest where the climate was cold, but these are variations that depend on geography, moisture availability, and other factors. Most observations of anomalous plume-induced snow are from the southern part of the zone examined, where the probability is relatively low. It is inferred that many instances occur in the high-probability region, but they are not generally detected because of the masking effects of natural snowfall and snow cover. The results of this work are sufficiently encouraging to suggest that a more comprehensive study including all radiosonde stations and a longer period of record would produce a planning document of considerable value.

27672 (SAND—79-7109) **Meteorological and air quality data quarterly report. WIPP site: Eddy County, New Mexico. Spring quarter, March-May 1977.** Pocalujka, L.P.; Babij, E.; Catizone, P.A.; Church, H.W. (Sandia National Labs., Albuquerque, NM (USA); TRC, Inc., Wethersfield, CT (USA)). Mar 1980. Contract AC04-76DP00789. 244p. NTIS, PC A11/MF A01.

The purpose of the WIPP meteorological, air quality, and radiological measurements program was to support the environmental effort for the evaluation of the site suitability. This data report is the fourth of a series of seasonal quarterly data summaries to be issued for the southeastern New Mexico site.

27673 (UCID—18730) **Theoretical and empirical basis for experimental simulation of maritime atmospheric dispersion at desert sites.** Shinn, J.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1980. Contract W-7405-ENG-48. 27p. NTIS, PC A03/MF A01.

The problem of experimental simulations of maritime meteorological conditions is discussed in terms of selecting or modifying the desert atmospheric environment so that particular criteria of dynanic similarity are met and the atmospheric dispersion test results may be generally applied. Fundamental scaling variables are defined, and it is shown how a shallow lake in the desert is a significant modification to the desert environment. Humidity and temperature gradients are presented and upwind fetch (horizontal extent) requirements are derived. Aerodynamic roughness of the shallow lake and rough seas are compared which results in a scale-up factor for wind speed. Temperature gradients, wind speed, mean air temperature, and atmospheric stability can be selected to permit a unique degree of control for experimental simulations giving an advantage over what would be obtained at any single oceanic site. Atmospheric turbulence, which predicts the lateral and vertical spread of diffusing plumes, is compared between oceanic and inland sites. Finally, the implications of normal atmospheric variability to experimental design, and the measurement requirements for atmospheric stability, aerodynamic roughness, and mixing zone depth are described.

27674 **Radiative heating of the global atmosphere: corrigendum.** Dopplick, T.G. (USAFETAC, Scott AFB, IL). *J. Atmos. Sci.;* **36**: No. 9, 1812-1817(Sep 1979).

Presented in Figs. 1 to 4 and Figs. 5 to 8 are the revised seasonal profiles of net thermal and total radiative heating. Thermal cooling predominates in the troposphere and is generally larger than previously calculated, especially in high latitudes. In low latitudes near the surface, the cooling is smaller because of the increased absorption of the downward thermal fluxes emitted by the cloud bases. When the new computations are used to compute the generation of available potential energy, the combined effect of these two changes should act to increase the generation. Total radiative heating is slightly less in the lower stratosphere due to the changes in the solar O_2 calculations.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 27348, 27664, 27691, 27696, 27947, 27948, 27949, 27950, 27973

27675 (ARI-RP—55) **Homogeneous production and removal of NO/sub x/ from combustion exhaust gases. Seventh quarterly technical summary report, 1 March-31 May 1980.** Silver, J.A.; Gozewski, C.M.; Kolb, C.E. (Aerodyne Research, Inc., Bedford, MA (USA)). Jun 1980. Contract ER-78-C-01-3183. 22p. NTIS, PC A02/MF A01.

The rate constants for the reaction OH + NH_3 → NH_2 + H_2O have been measured over the temperature range 294 - 1075 K. The data can be fit by the Arrhenius expression k(cm^3 $molecule^{-1}$ s^{-1}) = 5.41 +- 0.86 x 10^{-12} exp(-2120 +- 143 kcal mol^{-1}/RT). A chemical model of the NO/sub x/ chemistry has been developed which includes 54 reactions. Although not yet complete, the reaction set clearly indicates the key reaction is NH_2 + NO. The determination of the product channels and their branching ratios is of utmost importance in understanding the effect of NH_3 addition to combustor exhaust streams for removal of NO/sub x/.

27676 (DP—1557) **Environmental Transport Division: 1979 report.** Murphy, C.E. Jr.; Schubert, J.F.; Bowman, W.W.; Adams, S.E. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Mar 1980. Contract AC09-76SR00001. 61p. NTIS, PC A04/MF A01.

During 1979, the Environmental Transport Division (ETD) of the Savannah River Laboratory conducted atmospheric, terrestrial, aquatic, and marine studies, which are described in a series of articles. Separate abstracts were prepared for each. Publications written about the 1979 research are listed at the end of the report.

27677 (DP—1557, pp 11-20) **Atmospheric studies.** Mar 1980.

In Environmental Transport Division: 1979 report.

Several atmospheric transport and dispersion models were verified with krypton-85 emissions and meteorological data. As little as 5 x 10^4 atoms/cm^3 of helium-3 were detected to help determine the lateral spread of pollutants at distances beyond 25 km. The JEREMIAH computer system was expanded to: calculate a mass consistant, three-dimensional wind field; calculate three-dimensional pollutant transport and dispersion with second-moment and chapeau functions; allow input of krypton-85 releases on an hourly basis to compare observed with calculated krypton-85 measurements; include a real-time precipitation atmospheric transport model from Pacific Northwest Laboratories; and include a modified AD-PLUM module to predict concentration frequency distribution with greater accuracy. A new forecast method which uses Model Output Statistics predicts plume transport better than subjective techniques or persistance for forecasts. Two models accurately predict the mixed layer depth for a daytime situation. One uses thermodynamic arguments, and the other is a turbulent-entrainment model.

27678 (EML—374, pp I.13-I.24) **Aerosol chemical composition at American Samoa.** Bogen, D.C.; Nagourney, S.J.; Torquato, C.C. (Department of Energy, New York, NY). 1 Jul 1980.

In Environmental Measurements Laboratory. Environmental quarterly, March 1-June 1, 1980.

Air sampling was performed using a high volume sampler at a flow rate of /sup ~//m^3/min and Microsorban filters for particle collection. Two inch diameter filter discs are punched from the eight inch diameter filter and composited on a monthly basis. Water soluble anions and cations are extracted in a micro-Soxhlet apparatus and the extract is measured by ion chromatography, atomic absorption spectrometry and colorimetry to determine the air concentrations of the major anions and cations. The chemical composition of

the aeroosol is primarily sea spray although a depletion of Cl^- and excess of SO_4^{-2} relative to Na^+ is observed.

27679 (EML—374(App.), pp B.1-B.119) **Chemical composition of atmospheric deposition.** Feely, H.W.; Larsen, R.J. (Department of Energy, New York, NY). 1 Jul 1980.

In Appendix to Environmental Measurements Laboratory. Environmental quarterly.

The effects of changes in patterns of energy use upon the major element and trace element chemical composition of precipitation, dry deposition and total deposition are being studied. Samples of wet, dry and total deposition are collected on a monthly basis at seven sites within the conterminous United States. The main objective is to gather data on the geographical differences and time trends in precipitation chemistry and in concentrations of pollutants in deposition. At the contractor laboratory the pH and conductivity of each sample are measured. These data are subsequently compared with the equivalent data that were measured at EML. The sample is then analyzed in duplicate for ten major constituents: Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+, SO_4^{2-}, NO_3^-, Cl^-, PO_4^{3-}, and HCO_3^-. About four times a year the samples are measured in duplicate for ten trace metals: Al, Fe, Pb, V, Mn, Ni, Cr, Cd, Zn and As. Results are tabulated.

27680 (EPRI-EA—1394) **Inventory of organic emissions from fossil fuel combustion for power generation. Final report.** Zelenski, S.G.; Pangaro, N.; Hall-Enos, J.M. (GCA Corp., Bedford, MA (USA)). Apr 1980. 60p. NTIS, PC A04/MF A01.

A comprehensive summary of chemical and biological measurements on organic emissions from fossil-fuel-fired electric power generation facilities is presented. Individual data sets are presented, together with a brief summary of the experimental methods which were used to obtain them. In the past, combustion emissions were measured by many different methods which were not necessarily comparable, and thus the reliability of reported data has been estimated on the basis of supporting information in the report in which the data were published. Very few of the published reports gave adequate consideration to sample recovery and preservation, and this inadequacy underlies the lack of confidence which can be placed in most emission studies at fossil-fired power plants to date. The previously reported organic emissions have been very largely restricted to polycyclic aromatic hydrocarbons (PAH's), in part because of the concern for their potentially adverse health effects. Increased concern for the presence of biologically active materials in power plant emissions has led to the increased use of bioassay in the testing of emission samples. To date this testing has mainly been restricted to synthetic fuels and coal fly ash.

27681 (IS—4735) **Quarterly report, 1 October-31 December 1979.** (Ames Lab., IA (USA)). Mar 1980. Contract W-7405-ENG-82. 42p. NTIS, PC A03/MF A01.

Progress is reported in the following areas of research: characterization of organic pollutants emitted by fossil fuel processing and energy generating plants; environmental effects of using municipal solid wastes as a supplementary fuel; microbiological air quality at the Ames Municipal Solid Waste Recovery System; solid waste to methane environmental study; x-ray and ultraviolet excited optical luminescence (XEOL, UVEOL) of carcinogens - analytical possibilities; laser pumped luminescence (LPL) spectroscopy; multielement characterization of air particulates; and analytical results on SRC-II: NBS surrogate reference material. (JGB)

27682 (IS—4740) **Quarterly report, 1 January-31 March 1980.** (Ames Lab., IA (USA)). May 1980. Contract W-7405-ENG-82. 78p. NTIS, PC A05/MF A01.

Progress is reported in the following areas of research: characterization of organic pollutants emitted by fossil fuel processing and energy generating plants; environmental effects of using municipal solid wastes as a supplementary fuel; microbiological air quality at the Ames Municipal Solid Waste Recovery System; solid waste to methane environmental study; x-ray and ultraviolet excited optical luminescence (XEOL, UVEOL) of carcinogens - analytical possibilities; laser pumped luminescence (LPL) spectroscopy; personnel and plant monitors; and multi-element characterization of air particulates. Two papers submitted for publication are included. (JGB)

27683 (LA—8392-PR) **Aerosol sampling and characterization for hazard evaluation. Progress report, 1 October 1978-30 September 1979.** Scripsick, R.C.; Tillery, M.I.; Beckman, R.J. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 17p. NTIS, PC A02/MF A01.

Air samples were collected at two coal gasification facilities. Preliminary analysis indicates that leaks were isolated in both facilities. H_2S levels were, in general, < CO levels. At one facility, cyclohexane extractable levels were < 40 $\mu g/m^3$. Statistical analysis of dilution factor data between simulated releases and air samplers in a workroom was performed. This analysis isolated areas with relatively poor coverage and determined that the workroom's sampling system had a high probability of detecting a release of 10 times the maximum permissible air concentration from any of the release locations tested. The analysis determined that six was the optimum number of samplers in that workroom.

27684 (ORAU/IEA—80-9(M)) **Constraints on carbon dioxide production from fossil fuel use.** Rotty, R.M.; Marland, G. (Oak Ridge Associated Universities, Inc., TN (USA). Inst. for Energy Analysis). May 1980. Contract AC05-760R00033. 37p. NTIS, PC A03/MF A01.

The exponential growth of fossil fuel use over recent decades has resulted in a 4.3% annual increase in the carbon dioxide emitted to the atmosphere. The question addressed here is, when (and to what extent) will constraints limit the use of fossil fuels and the subsequent production of CO_2. Three types of possible constraints are discussed: resource constraints, fuel-demand constraints, and environmental constraints. An analysis of the next 50 years suggests that resource constraints will not provide severe limits. Fuel-demand constraints will probably limit the use of fossil fuels to levels that keep the atmospheric carbon dioxide concentration below 450 ppM(v) for the next 50 years, so that the impacts of atmospheric carbon dioxide will not cause mankind to take action soon. In spite of this conclusion a continuing, long-term problem is foreseen and full efforts to understand and continually monitor the CO_2 problem should be made and alertness to any changes that may require action should be maintained.

27685 (ORNL/TM—7286, pp 39-58) **Drift from mechanical draft cooling towers. Summary of results.** Laulainen, N.S. (Battelle Pacific Northwest Labs., Richland, WA). Apr 1980.

In Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1978-September 1979.

A summary of results of a comprehensive experiment to study drift from mechanical draft cooling towers is presented. The experiment was conducted at the PG and E Pittsburg Power Plant during June 1978. The objective of the experiment was to establish a data base for use in drift deposition model validation. The objective was met over a limited range of meteorological conditions by the simultaneous measurement of cooling tower source emission parameters, meteorological variables and drift deposition patterns. Source measurements are summarized for seven test runs while deposition results are given for six test runs.

27686 (PNL-SA—8674) **Preliminary report on physical, chemical and mineralogical composition and health implications of ash from the Mount St. Helens eruption of May 18, 1980.** (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76RL01830. 10p. NTIS, PC A02/MF A01.

On May 18, 1980 at 8:32 AM Pacific Daylight Time, a major eruption of ash and pyroclastics occurred from the Mount St. Helens volcano in Washington State. These and subsequent eruptions resulted in deposition of volcanic ash on large areas of the state of Washington and neighboring states. Beginning the day of the eruption and continuing through the following week, samples of the ash were collected for analysis by Battelle staff from various parts of eastern Washington and Montana. Specifically, samples were obtained from Richland, Yakima, Ahtanum, Tieton Ranger Station, Pullman, Rosalia, Moses Lake, Spokane, Ellensburg, Washington and Missoula, Montana. These materials were subjected to a variety of analyses including chemical, mineralogical and physical characterization and an in vitro biological assay to determine the effects of the ash on the pulmonary macrophage. This test gives an indication of the potential of the ash to cause respiratory diseases such as silicosis. Preliminary results of these various analyses are described.

27687 (RHO-CD—569) **NO/sub x/ emissions from Hanford nuclear fuels reprocessing plants.** Pajunen, A.L.; Dirkes, R.L. (Rockwell International Corp., Richland, WA (USA). Energy Systems Group). 15 Sep 1978. Contract AC06-77RL01030. 35p. NTIS, PC A03/MF A01.

Operation of the existing Hanford nuclear fuel reprocessing facilities will increase the release of nitrogen oxides (NO/sub x/) to the atmosphere over present emission rates. Stack emissions from two reprocessing facilities, one waste storage facility and two coal burning power plants will contain increased concentrations of NO/sub x/. The opacity of the reprocessing facilities' emissions is predicted to periodically exceed the State and local opacity limit of twenty percent. Past measurements failed to detect differences in the ambient air NO/sub x/ concentration with and without reprocessing plant operations. Since the facilities are not presently operating, increases in the non-occupational ambient air NO/sub x/ concentration were predicted from theoretical diffusion models. Based on the calculations, the annual average ambient air NO/sub x/ concentration will increase from the present level of less than 0.004 ppM to less than 0.006 ppM at the Hanford site boundaries. The national standard for the annual mean ambient air NO_2 concentration is 0.05 ppM. Therefore, the non-occupational ambient air NO/sub x/ concentration will not be increased to significant levels by reprocessing operations in the Hanford 200 Areas.

27688 Application of second-derivative uv-absorption spectrometry to polynuclear aromatic compound analysis. Hawthorne, A.R.; Thorngate, J.H. (Oak Ridge National Lab., TN). *Appl. Spectrosc.;* **33**: No. 3, 301-305(1979).

The increased awareness of the deleterious effects of polynuclear aromatic (PNA) compounds emphasizes the need for instruments that are capable of monitoring these compounds and also are suitable for use in health protection programs. Second-derivative uv-absorption spectrometry with least-squares spectral analysis shows promise as a method for analyzing vapor phase PNA's, as well as solutions containing these compounds. Detection limits of a few parts per billion are attainable for many PNA compounds. Examples are given showing the analytical capabilities of this procedure.

27689 Analysis of particulate sulfur and lead gradient data collected at Argonne National Laboratory. Everett, R.G.; Hicks, B.B.; Berg, W.W.; Winchester, J.W. (Argonne National Lab., IL). *Atmos. Environ.;* **13**: 931-934(1979).

Two automatic aerosol particle samplers were operated at heights of 11.5 and 34.5 m on the meteorological tower at Argonne National Laboratory (about 40 km southwest of Chicago) during the summer of 1976. Data obtained during one week of intensive study permit evaluation of the horizontal transport of both particulate sulfur and lead; sulfur was found to be associated with southwesterly flow, while lead appeared to originate in Chicago. By combining measurements of particle concentration gradients with wind and temperature gradients, deposition velocities of particulate sulfur have been computed for a range of atmospheric conditions. The resulting evaluations show a strong dependence on atmospheric stability and on wind speed. Although larger than values normally associated with particulate sulfur, the deposition velocities, averaging about 1.4 cm s^{-1}, compare favorably with both the momentum transfer velocity and some recently reported results obtained by application of eddy correlation methods.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 27011, 27672, 27720, 27743, 27861, 27883

27690 (EML—374(App.)) **Appendix to Environmental Measurements Laboratory. Environmental quarterly.** Toonkel, L.E. (Department of Energy, New York (USA). Environmental Measurements Lab.). 1 Jul 1980. 364p. NTIS, PC A16/MF A01.

Seperate abstracts were prepared on each of the first four appendixes. The last two appendixes include a table of conversion factors and a table of radionuclides. (JGB)

27691 (EML—374(App.), pp C.1-C.193) **Radionuclides and trace metals in surface air.** Feely, H.W.; Toonkel, L.E.; LArsen, R.J. (Department of Energy, New York, NY). 1 Jul 1980.

In Appendix to Environmental Measurements Laboratory. Environmental quarterly.

Continuing studies of the spatial and temporal distribution of specific natural and man-made radioisotopes, and of trace metals in the surface air are reported. The results of the completed analyses of radionuclides and gross gamma activity and of the concentrations of trace metals, as measured by atomic absorption or x-ray fluorescence, are tabulated. All of the radionuclide results are reported in either femtocuries (10^{-15} curies) or attocuries (10^{-18} curies) per standard cubic meter of air. The concentrations are reported at the midpoint of the collection month for beryllium, the plutonium isotopes, and the fission products. (JGB)

27692 (IS—4734) **Environmental monitoring at Ames Laboratory: Calendar year 1979.** Voss, M.D. (Ames Lab., IA (USA)). Apr 1980. Contract W-7405-ENG-82. 49p. NTIS, PC A03/MF A01.

The results and conclusions from the Ames Laboratory environmental monitoring programs for the Ames Laboratory Research Reactor (ALRR) are presented. The major areas of radiological monitoring were ALRR effluent air, environmental air, effluent water and environmental water. Analysis of air samples collected at the ALRR site showed detectable amounts of ^{60}Co. This isotope was 1.5 x 10^{-4}% of the concentration guide (1) and was probably due to ALRR operations. The radioisotope of significance in the ALRR stack effluent was tritium. The average yearly individual dose from ^{3}H at the exclusion fence was estimated to 0.0038 mRem and the estimated dose to the entire population within an 80 Km (50 mile) radius of the ALRR was 6.31 man-Rem. These values are 0.00076% and 0.0063%, respectively, of the doses derived from the concentration guides. In the radioactive liquid waste released to the City of Ames sewage system from the ALRR complex, ^{3}H was the predominant isotope. After dilution with other waste water from the ALRR complex, the potential dose was not more than 0.59% of the dose derived from the concentration guide.

27693 (LA—8379-MS) **Environmental and emergency response capabilities of Los Alamos Scientific Laboratory's radiological air sampling program.** Gunderson, T.C. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 19p. NTIS, PC A02/MF A01.

Environmental and emergency response radiological air sampling capabilities of the Environmental Surveillance Group at Los Alamos Scientific Laboratory are described. The air sampling program provides a supplementary check on the adequacy of containment and effluent controls, determines compliance with applicable protection guides and standards, and assesses potential environmental impacts on site environs. It also allows evaluation of potential individual and total population doses from airborne radionuclides that may be inhaled or serve as a source of external radiation. The environmental program is sufficient in scope to detect fluctuations and long-term trends in atmospheric levels of radioactivity originating onsite. The emergency response capabilities are designed to respond to both onsite unplanned releases and atmospheric nuclear tests.

27694 (MHSMP—80-12) **Environmental monitoring report for Plantex Plant covering 1979.** Alexander, R.E.; Cornelius, V.A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). May 1980. Contract AC04-76DP00487. 50p. NTIS, PC A03/MF A01.

The environmental monitoring program at Pantex Plant for 1979 is summarized. Monitoring data for both radioactive and nonradioactive species in the local environment are presented. Although plant activities involve the handling of significant quantities of uranium, plutonium, and tritium, only small releases of uranium (depleted in the isotope ^{235}U) and tritium occurred which could have affected the local environment. Monitoring data indicate that concentrations of these nuclides in the environment are below established criteria for air and water and therefore do not present a health hazard either to employees or to the public.

27695 (NLCO—004EV) **Review of radon monitoring at the DOE-Niagara Falls Storage Site.** Humphrey, H.W. (National Lead Co. of Ohio, Cincinnati (USA)). 31 Mar 1980. Contract AC05-76OR01156. 85p. NTIS, PC A05/MF A01.

Radon-222 monitoring results over the period May 1978 to February 1980 are reviewed and summarized. Radon-222 levels in inhabited areas surrounding the storage site were all found to be no greater than 0.5 pCi/l compared to an average ambient air background for the region of 0.23 +- 0.01 pCi/l. Ambient air radon levels rapidly approach background within 0.5 to 1.0 mile from the storage site. Weekly surveillance information, averaged over a year, indicates that six of the eight fenceline ambient air monitoring stations showed concentrations well within the concentration guide limit of 3.0 pCi/l for uncontrolled areas. The remaining two adjacent stations (along the western boundary fence) showed elevated average radon levels of 4.28 and 5.68 pCi/l, respectively. The higher levels at the western boundary fence are attributed to the Spoil Pile area, which is within a hundred feet of the present boundary fence. Maxima were observed in both soil air and ambient air monthly radon levels, which correlate closely with meteorological parameters. A spoil pile radon flux survey is described which identifies radon source isopleths and quantifies yearly average pile emissions. Average offsite radon flux from soil was found to be 0.14 +- 0.07 pCi/m^2-s. Weighted average (yearly) radon flux from the spoil pile was found to be 407 pCi/m^2-s. The effects of applying asphaltic emulsion, or water, to reduce radon emissions are discussed. Application of asphaltic emulsion to residues in storage buildings resulted in an average reduction in radon emissions of 94%. Variables affecting radon emanation and measurement are discussed, including: instrumentation; meteorological conditions; and source distribution and magnitude. Recommendations are suggested to improve the existing radon monitoring program and future useful innovations are discussed.

27696 (PNL—3283) **Environmental surveillance at Hanford for CY-1979.** Houston, J.R.; Blumer, P.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract AC06-76RL01830. 72p. NTIS, PC A04/MF A01.

Environmental data were collected for most environmental media including air, Columbia River water, external radiation, foodstuffs (milk, beef, eggs, poultry, and produce) and wildlife (deer, fish, and game birds), as well as soil and vegetation samples. In general, offsite levels of radionuclides attributable to Hanford operations during 1979 were indistinguishable from background levels. The data are summarized in the following highlights. Air quality measurements of NO_2 in the vicinity of the Hanford Site and releases of SO_2 onsite were well within the applicable federal and state standards. Particulate air concentrations exceed the standards primarily because of agricultural activities in the area. Discharges of waste water from Hanford facilities in the Columbia River under the National Pollution Discharge Elimination System (NPDES) permit were all within the parameter limits on the permit.

27697 (PNL—3300(Pt.1), pp 145-146) **Spectrophotometric determination of uranium and plutonium in LMFBR fuel-sodium aerosols.** Morgan, L.G.; Ryan, J.L.; Allen, M.D.; Briant, J.K. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Spectrophotometric investigations of sodium-$(Pu,U)O_2$ and sodium-PuO_2 aerosols were conducted with aerosols collected both in dry air on filters or in impinger solutions. These studies confirm previous observations (Annual Report, 1978) that the uranium present in the LMFBR fuel-sodium aerosol was rapidly converted to a soluble uranyl carbonate complex ion species in the presence of air and moisture. In addition, our results demonstrate that previous speculations concerning the valence of plutonium in the aerosol must be reexamined.

27698 (PNL—3300(Pt.1), pp 147-149) **Measurements of dynamic shape factors of LMFBR aggregate aerosols.** Allen, M.D.; Moss, O.R.; Briant J.K. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Dynamic shape factors for branched, chain-like aggregates of LMFBR mixed-oxide fuels have been measured with a LAPS spiral-duct centrifuge. The aerosol was generated by repeatedly pulsing a focused laser beam onto the surface of a typical LMFBR fuel pellet. The measured values of the dynamic shape factor, corrected for slip, vary between $\kappa = 3.60$ at D/sub ae/ $= 0.5$ μm, and $\kappa = 2.23$ at D/sub ae/ $= 1.5$ μm.

27699 (PNL—3368) **Real-time measurement of plutonium in air by direct-inlet surface ionization mass spectrometry. Status report.** Stoffels, J.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract AC06-76RL01830. 18p. NTIS, PC A02/MF A01.

A new technique is being developed for monitoring low-level airborne plutonium on a real-time basis. The technique is based on surface ionization mass spectrometry of airborne particles. It will be capable of measuring plutonium concentrations below the maximum permissible concentration (MPC) level. A complete mass spectrometer was designed and constructed for this purpose. Major components which were developed and made operational for the instrument include an efficient inlet for directly sampling particles in air, a wide dynamic range ion detector and a minicomputer-based ion-burst measurement system. Calibration of the direct-inlet mass spectrometer (DIMS) was initiated to establish the instrument's response to plutonium dioxide as a function of concentration and particle size. This work revealed an important problem - bouncing of particles upon impact with the ionizing filament. Particle bounce results in a significant loss of measurement sensitivity. The feasibility of using an oven ionizer to overcome the particle bounce problem has been demonstrated. A rhenium oven ionizer was designed and constructed for the purpose of trapping particles which enter via the direct inlet. High-speed particles were trapped in the oven yielding a measurement sensitivity comparable to that for particles which are preloaded. Development of the Pu DIMS can now be completed by optimizing the oven design and calibrating the instrument's performance with UO_2 and CeO_2 particles as analogs to PuO_2 particles.

27700 (RHO-CD—79-35-4Q) **Radioactivity in gaseous waste discharged from the separations facilities during fourth quarter of 1979.** Sliger, G.J. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). 22 Feb 1980. Contract AC06-76RL01830. 41p. NTIS, PC A03/MF A01.

This document is issued quarterly for the purpose of summarizing the radioactive gaseous wastes that are discharged from the facilities of the Rockwell Hanford Operations (Rockwell). Data on alpha and beta emissions during 1979 are presented where relevant to the gaseous effluent. Emission data are not included on gaseous wastes produced within the 200 areas by other Hanford contractors.

27701 (SAND—80-0342) **Sandia National Laboratories 1979 environmental monitoring report.** Simmons, T.N. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 28p. NTIS, PC A03/MF A01.

Sandia National Laboratories in Albuquerque is located south of the city on two broad mesas. The local climate is arid continental. Radionuclides are released from five technical areas from the Laboratories' resarch activities. Sandia's environmental monitoring program searches for cesium-137, tritium, uranium, alpha emitters, and beta emitters in water, soil, air, and vegetation. No activity was found in public areas in excess of local background in 1979. The Albuquerque population receives only 0.076 person-rem (estimated) from airborne radioactive releases. While national security research is the laboratories' major responsibility, energy research is a major area of activity. Both these research areas cause radioactive releases.

27702 (SAND—80-0366(Rev.)) **Observations on the use of the consequence model CRAC for small nonreactor atmospheric releases.** Ericson, D.M. Jr. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 28p. NTIS, PC A03/MF A01.

The consequence model CRAC from the Reactor Safety Study was recently applied to atmospheric releases of radioactive material from nonreactor sources. This study examines the effect of three model parameters, interval size, population distribution and plume thermal bouyancy, on the consequence estimates. Recommendations for the appropriate use of CRAC in such consequence studies are included.

27703 **Plutonium isotopes in the atmosphere.** Gavini, M.B.; Kuroda, P.K. (Univ. of Arkansas, Fayetteville). *Geochem. J. (Nagoya);* **11**: 257-260(1977).

The concentrations of ^{238}Pu and $^{239,240}Pu$ were measured in surface air and rain samples collected at Fayetteville (36°N, 94°W), Arkansas, during the period between October 1971 and November 1973. The $^{238}Pu/^{239,240}Pu$ ratios in many of the samples were found to be in the range between 0.1 and 0.3. These results indicate that appreciable amounts of ^{238}Pu are being injected into the atmosphere by the recent nuclear weapons tests.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

27704 (ORNL/TM—7286, pp 117-146) **Physical modeling of flow over an axisymmetric knoll under neutral atmospheric conditions.** Cliff, W.C.; Smith, J.D. (Pacific Northwest Lab., Richland, WA). Apr 1980.

In Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1978-September 1979.

A glass-walled hydraulic (water) flume was used to physically model air flow near an axisymmetric knoll in a neutral atmospheric boundary layer. The knoll was a 1:250 scale model. An upstream velocity profile (1/7 power law), characteristic of a neutral atmospheric boundary layer, was produced by locating a 10-cm-high (4-in.) trip near the flume entrance and by appropriately roughening the flume floor. Mean velocity, rms velocity, and turbulence intensity profiles were measured at locations near the knoll using an existing laser Doppler anemometer system. The flow accelerated over the knoll and produced a relatively uniform velocity profile at the crest. The measured velocity profile was in close agreement with a theoretical velocity profile developed using potential flow theory and an upstream power law velocity profile. The turbulence intensity decreased at the crest of the knoll as a result of the flow acceleration.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 27848

27705 (CONF-800376—1) **Ecosystem theory and the unexpected: implications for environmental toxicology.** O'Neill, R.V.; Waide, J.B. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 42p. NTIS, PC A03/MF A01.

From Toxic substances in the environment; Battelle Columbus, OH, USA (Mar 1980).

The necessity of considering in research, the components of ecosystems as parts of the dynamic whole is emphasized. Certainly a major focus of toxic substance programs should be understanding effects on the state of the whole ecosystem. In the first section the notion of the system as it emerges from hierarchy theory is developed. The next section emphasizes the ecosystem as a biogeochemical system. Next the focus is placed explicitly on the system-component problem, and ecological examples of problems involved in extrapolating from component measurements to system behaviors are given. Recommendations for toxic substances research are included.

27706 (CONF-800478—1) **Overview of multivariate methods and their application to studies of wildlife habitat.** Shugart, H.H. Jr. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 22p. NTIS, PC A02/MF A01.

From Workshop on the use of multivariate statistics in studies of wildlife habitat; Burlington, VT, USA (23 Apr 1980).

Multivariate statistical techniques as methods of choice in analyzing habitat relations among animals have distinct advantages over competitive methodologies. These considerations, joined with a reduction in the cost of computer time, the increased availability of

multivariate statistical packages, and an increased willingness on the part of ecologists to use mathematics and statistics as tools, have created an exponentially increasing interest in multivariate statistical methods over the past decade. It is important to note that the earliest multivariate statistical analyses in ecology did more than introduce a set of appropriate and needed methodologies to ecology. The studies emphasized different spatial and organizational scales from those typically emphasized in habitat studies. The new studies, that used multivariate methods, emphasized individual organisms' responses in a heterogeneous environment. This philosophical (and to some degree, methodological) emphasis on heterogeneity has led to a potential to predict the consequences of disturbances and management on wildlife habitat. One recent development in this regard has been the coupling of forest succession simulators with multivariate analysis of habitat to predict habitat availability under different timber management procedures.

27707 (CONF-800549—3) **Modeling the role of terrestrial ecosystems in the global carbon cycle.** Emanuel, W.R.; Post, W.M.; Shugart, H.H. Jr. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 16p. NTIS, PC A02/MF A01.

From 11. annual modeling and simulation conference; Pittsburgh, PA, USA (1 May 1980).

A model for the global biogeochemical cycle of carbon which includes a five-compartment submodel for circulation in terrestrial ecosystems of the world is presented. Although this terrestrial submodel divides carbon into compartments with more functional detail than previous models, the variability in carbon dynamics among ecosystem types and in different climatic zones is not adequately treated. A new model construct which specifically treats this variability by modeling the distribution of ecosystem types as a function of climate on a 0.5° latitude by 0.5° longitude scale of resolution is proposed.

27708 Effects of sex, age, habitat, and body weight on kidney weight in white-tailed deer. Johns, P.E.; Smith, M.H.; Chesser, R.K. (Univ. of Georgia, Aiken, SC). Contract EY-76-C-09-0819. *Growth;* **44**: No. 1, 46-53(Mar 1980).

Kidney (Y) and body (X) weights in kilograms are highly correlated ($r = 0.88$) in white-tailed deer. As in other mammals, the relationship between the two variables is curvilinear with $Y = 2.493 X^{0.748}$. Habitat did not affect the parameters of the relationship although certain sex-age and sex month categories did. However, use of kidney weight in standardizing body condition indices in deer of different sizes still seems warranted for white-tailed deer in the Southeastern United States during the hunting season because of the relatively high predictability of the overall kidney-body weight relationship.

27709 Use of Pb-210 geochronology as a sedimentological tool: application to the Washington continental shelf. Nittrouer, C.A.; Sternberg, R.W.; Carpenter, R.; Bennett, J.T. (Univ. of Washington, Seattle). *Mar. Geol.;* **31**: 297-316(1979).

In the past, marine sedimentologists have been unable to quantitatively investigate modern sediment accumulation on continental shelves, but recent development of Pb-210 geochronology provides a tool to overcome this limitation. It is used in this study to examine the accumulation of modern Columbia River sediments on the Washington continental shelf. Pb-210 profiles in Washington shelf sediments reveal three characteristic regions: a homogeneous surface layer (about 10 cm thick) where sediments are actively mixed by physical and biological processes, a region where Pb-210 activities decrease logarithmically with depth in the sediment, and a lower region of background activities. The surface mixed layer generally reflects erosion by wave and current activity in inner shelf sediments (shallower than about 60 m), and biological mixing in mid and outer shelf sediments. The region of logarithmic activities (i.e., radioactive decay) in the Pb-210 profiles provides the rate of sediment accumulation, which is on the order of mm/y. The predominant depositional feature is a mid-shelf silt deposit in which accumulation rates progressively decrease north-northwestward away from the Columbia River. These results are consistent with other sedimentological observations, and indicate that Pb-210 geochronology not only allows determination of modern sediment accumulation rate but also provides additional insight into processes affecting accumulation. Pb-210 geochronology can be an important sedimentological tool for future studies of continental shelf sedimentation in areas undergoing modern sediment accumulation.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 27920, 27975

27710 (BNL—27851) **Sensitivity of the eastern United States to acid precipitation impacts on surface waters.** Hendrey, G.R.; Galloway, J.N.; Norton, S.A.; Schofield, C.L. (Brookhaven National Lab., Upton, NY (USA); Virginia Univ., Charlottesville (USA); Maine Univ., Orono (USA); Cornell Univ., Ithaca, NY (USA)). Mar 1980. Contract AC02-76CH00016. 7p. (CONF-800365—3). NTIS, PC A02/MF A01.

From International conference on the ecological impact of acid precipitation; Sandefjord, Norway (11 Mar 1980).

Efforts to identify areas of the United States where soils and freshwaters might be sensitive to acidification have proceeded from analyses of large scale geologic maps. These are useful in a general way but a finer scale analysis has been needed. We have carried out such an analysis for the eastern United States based primarily on geologic maps of scales 1:250,000 to 1:500,000. This report is a synopsis of and excerpted from that effort. Other workers have prepared maps on a similar scale of the soils to a depth of 25 cm, and we anticipate that both sets of maps will be merged into a combined analysis of sensitivity. Other factors important in controlling acidification of soils and freshwaters include hydrologic charcteristics of the terrain, such as: soil porosity or permeability; water residence time in soil; temporal variation in precipitation rate, chemistry and volume; regional temperature patterns; and topography.

27711 (EPA—600/8-80-017) **EPA Research Summary: controlling hazardous wastes.** (Environmental Protection Agency, Washington, DC (USA). Office of Research and Development). May 1980. 26p. Environmental Protection Agency, Washington, DC.

An estimated 90% of the hazardous waste generated in the United States is disposed of by environmentally unsound methods. This report presents a brief description and summary of the problem and of the areas of research conducted by the Environmental Protection Agency. (ACR)

27712 (ORNL/EPA—4) **Microcosms as potential screening tools for evaluating transport and effects of toxic substances.** Ausmus, B.S.; Eddlemon, G.K.; Draggan, S.J.; Giddhings, J.M.; Jackson, D.R.; Luxmoore, R.J.; O'Neill, E.G.; O'Neill, R.V.; Ross-Todd, M.; Van Voris, P. (Environmental Protection Agency, Washington, DC (USA). Office of Research and Development; Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 404p. (EPA—600/3-80-042). NTIS, PC A18/MF A01.

Terrestrial and aquatic microcosms were evaluated for use in research on environmental contaminants. Research completed in this project attempted to: (1) evaluate relationships among size, complexity, stability, and replicability; (2) assess the simularity between microcosm results and actual environmental transport and effects; (3) identify and quantify system-level parameters that might be sensitive indicators of effects of chemical contaminants; (4) determine the relationship between system-level parameters measured in microcosms and in natural ecosystems; and (5) suggest protocols for establishing, maintaining, and interpreting results from microcosms. A number of experimental approaches using several microcosm designs and contaminants are reported. The use of terrestrial microcosm results was evaluated in conjunction with mathematical simulation models as a means of extending short-term exprimental results to interpret conditions as they might occur in the natural ecosystem. Although microcosms offer an excellent experimental system, their application to toxic substance testing is not a straightforward matter. They are characterized by complex dynamics and counterintuitive responses just as is the ecosystem to which they are an analog. These factors notwithstanding, microcosms do offer an excellent means of studying specific aspects of contaminant behavior and ecosystem processes. With appropriate attention to the design of specific questions, answers to which are relevant to interpreting ecological transport and effects of contaminants, microcosms can be useful tools.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 27725, 27743

SOIL

REFER ALSO TO CITATION(S) 27007, 27008, 27011, 27692, 27695, 27883

27713 (DP—1557, pp 21-32) **Terrestrial studies.** Mar 1980.

In Environmental Transport Division: 1979 report.

Tritium in the organic fraction of soil, separated as water by high temperature combustion, was 5 to 50 times higher in activity than water that was freeze-dried from the same samples. The 50-year dose commitment from ingestion of crops is not influenced significantly by the plutonium in the SRP environment. This plutonium is a result of more than 20 years of operating chemical separations facilities. Techniques were developed to detect as little as 0.02 pCi/m^2 of iodine-129 and 0.2 pg of technetium-99 in soil to evaluate environmental effects. A sensitive three-stage mass spectrometer was completed for use in environmental studies of transuranium ele-

ments. Results of monitoring particle size distribution of entrapped particles containing Pu-238, and Pu-239,240 are reported.

27714 (EGG—1183-1719) **Aerial radiological survey of the area surrounding the Portsmouth Gaseous Diffusion Plant, Portsmouth, Ohio.** (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1979. Contract AC08-76NV01183. 21p. NTIS, PC A02/MF A01.

An airborne radiological survey was conducted in July 1976. It was centered on the Portsmouth Gaseous Diffusion Plant. Two areas were surveyed: one 35 km^2 and the other 16 km^2. Using NaI(Tl) scintillation detectors, measurements were made of the terrestrial gamma radiation over the areas with a series of north-south flight lines. The processed data indicated that on-site radioactivity was due to nuclear matterials currently or previously handled, processed, or stored. Off-site activities were found to be due wholly to the naturally occurring ^{40}K, the ^{238}U chain, and thorium chain gamma emitters.

27715 (EGG—1183-1751) **Aerial radiological surveys of Rockwell International Facilities, Canoga Park, California. Dates of surveys: June and July 1978.** Jobst, J.E. (EG and G, Inc., Las Vegas, NV (USA). Energy Measurements Group). Oct 1979. Contract AC08-76NV01183. 31p. NTIS, PC A03/MF A01.

Aerial radiological surveys were conducted over two facilities. The first survey, conducted on 26 and 27 June 1978 at an altitude of 46 m, was over the Headquarters Facility in urban Canoga Park, California. The second, on 29 and 30 June and 5 to 8 July 1978, was flown at 61 m altitude over the Santa Susana Field Laboratories in the Santa Susana Mountains, about 15 km west-northwest of the Headquarters. Twenty sodium iodide detectors were mounted on a helicopter. Enhanced gamma exposure rate levels were observed during both surveys; these levels could be attributed to industrial operations at the survey sites.

27716 (EML—374(App.), pp A.1-A.41) **Quarterly ^{90}Sr deposition at world land sites.** Toonkel, L.E. (Department of Energy, New York, NY). 1 Jul 1980.

In Appendix to Environmental Measurements Laboratory. Environmental quarterly.

The results of quarterly ^{90}Sr data at 77 sites beginning in 1976 are reported. Of the 77 sites for which quarterly data are reported, the montly collections at 69 sites are composited and analyzed quarterly starting with the July 1976 samples. Data reported for the first half of 1976 at these sites as well as for the whole year at New York City and through June 1977 at the Australian sites, are quarterly results obtained by summing the monthly data. As of July 1977, the Australian sites have changed over to quarterly collection. The collections are made using either high-walled stainless steel pots with exposed areas of 0.076 square meters or plastic funnels with exposed areas of 0.072 square meters to which are attached ion-exchange columns. A few sites which were established as part of a precipitation chemistry network use plastic pots with an area of 0.064 square meters for collection.

27717 (EML—375) **Cesium-137 inventories in undisturbed Utah soils: interim report on radionuclides in soils of populated areas.** Beck, H.L.; Krey, P.W. (Department of Energy, New York (USA). Environmental Measurements Lab.). Jun 1980. 41p. NTIS, PC A03/MF A01.

Cesium-137 inventories in undisturbed soils at over 150 sites throughout Utah have been estimated from in situ gamma-ray spectra and analyses of soil samples obtained in June 1979. It appears, based on a preliminary analysis, that the maximum ^{137}Cs fallout on southwestern Utah from nuclear weapons tests carried out at the Nevada Test Site was about 50 mCi/km^2. It is estimated that this level of activity would have generated a cumulative free air dose from all fission products of less than 5 rad, which is in reasonable agreement with the value inferred from the radiation surveys conducted after each of the Nevada tests. This suggests that the residents of southwestern Utah were not exposed to external radiation from the Nevada tests significantly greater than had previously been reported. Planned mass isotopic analyses of the plutonium present in the soil samples should permit a more precise estimate of the external radiation doses delivered at each site.

27718 (ESG—80-7) **Energy systems group environmental monitoring and facility effluent. Annual report 1979.** Moore, J.D. (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). 25 Apr 1980. Contract EY-76-C-04-3533. 59p. NTIS, PC A04/MF A01.

Soil, vegetation, and surface water were routinely sampled for radioactivity to a distance of 10 miles from Energy Systems Group (ESG) sites. Continuous ambient air sampling and radiation monitoring by thermoluminescent dosimetry are performed on-site for measuring airborne radioactivity concentrations and site ambient radiation levels. Radioactivity in effluents discharged to the atmosphere from ESG facilities is continuously sampled and monitored to ensure that levels released to unrestricted areas are within appropriate limits, and to identify processes which may require additional engineering safeguards to minimize radioactivity levels in such effluents. In addition, selected nonradioactive constituent concentrations in surface water discharged to unrestrictted areas are determined. Monitoring results for 1979 are summarized and discussed. The random variations observed in the environmental monitoring data indicate that no local source of unnatural radioactive material exists in the environs. Additionally, the similarity between on-site and off-site results further indicates that the contribution to general environmental radioactivity due to operations at the ESG is essentially nonexistent. The environmental radioactivity reported herein is attributed to natural sources and to fallout of radioactive material from foreign atmospheric testing of nuclear devices.

27719 (ORNL—5464) **Radiological survey of the inactive uranium-mill tailings at Lakeview, Oregon.** Haywood, F.F.; Burden, J.E.; Ellis, B.S.; Loy, E.T.; Shinpaugh, W.H. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 40p. NTIS, PC A03/MF A01.

The results of the radiological survey of the inactive uranium-mill site at Lakeview, Oregon, show that the average gamma-ray exposure rate 1 m above the tailings pile and the evaporation pond area (now dry) is close to the average background level for the area (11 $\mu R/hr$). The ^{226}Ra concentration in most of the surface soil and sediment samples is also at or below the average background value for surface soil samples in the area (0.8 pCi/g). Calculated ^{226}Ra concentrations, based on gamma radiation measurements in shallow (1-m-deep) holes, are in agreement with the results of surface soil and sediment analyses and with gamma-ray exposure rate measurements. The tailings at this site have been stabilized by the addition of 46 to 60 cm (18 to 24 in.) of soil that supports vigorous growth of vegetation. This treatment, coupled with a low-level inventory of ^{226}Ra in the tailings (50 Ci), has resulted in limited spread of tailings by wind and water.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 27690, 27694, 27713, 27861

27720 (EML—374) **Environmental Measurements Laboratory. Environmental quarterly, March 1-June 1, 1980.** Hardy, E.P. Jr. (Department of Energy, New York (USA). Environmental Measurements Lab.). 1 Jul 1980. 69p. NTIS, PC A04/MF A01.

Current information from the EML environmental programs, the Air Monitoring Section of the Bhabha Atomic Research Centre and the Radiological and Environmental Research Division at Argonne National Laboratory is reported. The initial section consists of interpretive reports and notes dealing with strontium-90 in human bone from Bombay, chemical composition of the aerosol at American Samoa, and strontium-90 in New York and San Francisco diets. Subsequent sections include tabulations of strontium-90 fallout, chemical constituents of wet and dry deposition, radionuclide and trace metal concentrations in surface air, and strontium-90 concentrations in human bone, milk and tap water. A bibliography of recent publications related to environmental studies is also presented. Separate abstracts were prepared for four of the sections.

27721 (EML—374, pp I.3-I.11) **Strontium-90 in human bones from Bombay.** Lalit, B.Y.; Anand, S.J.S. (Bhabha Atomic Research Centre, Bombay, India). 1 Jul 1980.

In Environmental Measurements Laboratory. Environmental quarterly, March 1-June 1, 1980.

Data on ^{90}Sr content of human bond samples collected during 1958-69 period at Bombay is presented. Brief description of the sampling and analytical procedures is also given. It is noticed that even though the ^{90}Sr levels in Bombay diet and milk samples were low in comparison to some western countries, the ^{90}Sr content of adult bones were comparable for Bombay and those of western countries.

27722 (EML—374, pp I.25-I.42) **Strontium-90 in the diet: results through 1979.** Klusek, C.S. (Department of Energy, New York, NY). 1 Jul 1980.

In Environmental Measurements Laboratory. Environmental quarterly, March 1-June 1, 1980.

Estimates of ^{90}Sr intake via the total diet in New York City and San Francisco have been made since 1960 from quarterly food samplings and avrage consumption statistics. The dietary intakes of ^{90}Sr have decreased from the maximum levels attained during 1963-64, but the declines have become more gradual in recent years due to the continuing small amounts of ^{90}Sr deposition and the little-changing cumulative deposit of ^{90}Sr in soil. The annual intake in 1979 averaged 8.3 pCi/day in New York and 2.8 pCi/day in San Francisco. Further gradual reductions in ^{90}Sr intake are anticipated during 1980.

27723 (EML—374, pp III.3-III.6) **Cesium-137 in various Chicago foods.** Karttunen, J.O. (Argonne National Lab., IL). 1 Jul 1980.

In Environmental Measurements Laboratory. Environmental quarterly, March 1-June 1, 1980.

Since Apruil 1861, the ^{137}Cs and potassium content of the Chicago portion of the Tri-City Diet Sampling Program has been determined in bulk food samples by gamma-ray spectrometry using a 4" x 4" NaI (TI) crystal. Each variety of food (all fresh vegetables, all fresh fruit, etc.) is composited before measurement, and each sample is counted 400 to 1000 minutes. From these measurements composite daily and yearly food intakes are obtained. The results for the April 1980 semi-annual sampling are presented.

27724 (EML—374(App.), pp D.1-D.7) **Radiostrontium in milk and tap water.** 1 Jul 1980.

In Appendix to Environmental Measurements Laboratory. Environmental quarterly.

The New York City sample is a monthly composite of pasteurized milk purchased daily at retail stores. The monthly Sr-90 to calcium ratios for New York City since the inception of the sampling program in 1954 are tabulated. These data are also presented graphically. Samples of New York City tap water are taken daily so that by the end of the month, approximately 100 liters have been collected. The Sr-90 data since the inception of the program are presented. The available cesium-137 data expressed as the Cs-137 to Sr-90 ratio are also given.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 26938, 26941, 26942, 26943, 26990, 27005, 27008, 27010, 27365, 27577, 27578

27725 (RHO-SA—169) **Methods and costs for soil removal.** Toomey, J.E. (Rockwell International Corp., Richland, WA (USA). Energy Systems Group). Dec 1979. Contract AC06-77RL01030. 15p. (CONF-791234—3). NTIS, PC A02/MF A01.

From Environmental decontamination workshop; Oak Ridge, TN, USA (4 Dec 1979).

Surface stabilization of outdoor radiation areas is discussed. Soil transport via shovel and box, dump truck, and scraper is described. Surface preparation includes application of herbicides, fertilizers and seeds. Finally, mulch is applied to hold the seed in place until it germinates. (DC)

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 27667, 27668, 27705, 27754

27726 (BNL—27757) **Short term variation in the vertical distribution of copepods off the coast of northern Peru.** Smith, S.L.; Boyd, C.M.; Lane, P.V.Z. (Brookhaven National Lab., Upton, NY (USA)). Apr 1980. Contract EY-76-C-02-0016. 28p. (CONF-800237—2). NTIS, PC A03/MF A01.

From International symposium on coastal upwelling; Los Angeles, CA, USA (4 Feb 1980).

Vertical profiles of chlorophyll a, oxygen, density and copepods were collected during November 1977 near 9°S off Peru. The majority of three groups of copepod, the Oncaeidae, the Oithonidae and small calanoids, remained above the depth (~ 30m) where concentrations of oxygen became less than 0.5 $ml.l^{-1}$ both day and night. Centers of population of all three groups were in or below the pycnocline at all times. In daytime all three groups accumulated at depth, while at night all three groups showed some dispersion throughout the upper 30 m with statistically significant separation in the layers of Oncaeidae and small calanoids. Small calanoids were always higher in the water column than the Oncaeidae at night. The rather small, daily vertical excursions by the Oncaeidae and small calanoids exposed them to mean onshore, poleward flow by day and mean offshore, equatorward flow at night.

27727 (BNL—27847) **Benthic plant communities in acidic Lake Colden, New York: Sphagnum and the algal mat.** Hendrey, G.R.; Vertucci, J.A. (Brookhaven National Lab., Upton, NY (USA); Cornell Univ., Ithaca, NY (USA)). Mar 1980. Contract AC02-76CH00016. 13p. (CONF-800365—4). NTIS, PC A02/MF A01.

From International conference on the ecological impact of acid precipitation; Sandefjord, Norway (11 Mar 1980).

Lake Colden, in the central Adirondack Mountains of New York State is botanically similar to acidified lakes in Sweden. Acidification of some Swedish lakes has been associated with an expansion of Sphagnum, primarily in shallow, sheltered littoral areas but also to depths of 18m. During a brief botanical survey on 24-25 July 1979, we observed a dense meadow of Sphagnum pylaesii around much of the shoreline of Lake Colden. Plant community composition was determined by a visual estimate of cover along a single typical transect and through underwater photography on 28-29 August 1979. Water samples were collected and returned to our laboratory for analyses several days later. Sample pH was determined by potentiometry and alkalinity by multiple end point titrations. Biomass samples were also taken of the Sphagnum mat community and dry weight was determined. Chemical content of plant tissue was analyzed.

27728 (BNL—27850) **Temporal and spatial trends in the chemistry of acidified lakes under ice cover.** Hendrey, G.R.; Galloway, J.N.; Schofield, C.L. (Brookhaven National Lab., Upton, NY (USA); Virginia Univ., Charlottesville (USA); Cornell Univ., Ithaca, NY (USA)). Mar 1980. Contract AC02-76CH00016. 7p. (CONF-800365—6). NTIS, PC A02/MF A01.

From International conference on the ecological impact of acid precipitation; Sandefjord, Norway (11 Mar 1980).

When preparing materials budgets for watersheds containing lakes, the spatial and temporal interchange between large compartments within the whole system must be considered. This paper addresses the lakes of the Integrated Lake-Watershed Acidification Study (ILWAS) and their role in our mass balance calculations for the period of winter stratification of 1978-1979, and presents data on lake metabolism.

27729 (CONF-800654—1) **Comparative reservoir research at Oak Ridge National Laboratory.** Van Winkle, W.; Coutant, C.C.; Elwood, J.W.; Hildebrand, S.G.; Mattice, J.S.; McLean, R.B. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 23p. NTIS, PC A02/MF A01.

From Symposium on surface water impoundments; Minneapolis, MN, USA (2 Jun 1980).

Examples are given of research being conducted to gain an understanding of the key biotic and abiotic components and processes important for reservoir stability. These include studies on the effects of power plant thermal discharges, the thermal niche concept (of fish habitat), causes of impingement at power plants, forage fish population dynamics and interactions with predators, fouling of power plant condenser tubes, population dynamics and trophic interactions of the Asiatic clam. The concept of comparative reservoir research is discussed, and its use in studies of energy technology impacts and siting criteria for southeastern aquatic systems are discussed.

27730 (DP—1557, pp 33-46) **Aquatic studies.** Mar 1980.

In Environmental Transport Division: 1979 report.

Thermal stress to microorganisms was measured by the production of dissolved organic matter by algal communities and the mineralization of glucose by heterotrophic populations. Mutagenic activity as measured by the Ames/Salmonella/microsome assay indicate that such activity does not occur in Par Pond, although limited mutagenic activity does occur in a nearby canal system due to chlorination of cooling water. Sodium hypochlorite, used as an algicide in the reactor fuel storage basins, caused increased pitting corrosion to reactor fuel targets. Five other compounds selected for testing proved to be superior to sodium hypochlorite. Legionella pneumophila, the pathogen which causes Legionnaire's disease, was found to be a natural part of aquatic ecosystems. It occurs over a wide range of environments and is able to utilize nutrients provided by primary producers. Phytoplankton size classes of less than 3 μm (less than 5% of the total phytoplankton biomass) accounted for 15 to 40% of the total primary productivity in Par Pond, Pond C, and Clark Hill Reservoir. Three major biological data sets were compiled and are available in the SRL computer system for analysis: the SRP deer herd data; 20 years of Par Pond data; and 25 years of biological data on the Savannah River. Results of marine studies indicated that nearly all plutonium in the Savannah River and its estuary resulted from nuclear weapons fallout. The plutonium concentration in the Savannah River is about one fourth the concentration in the Newport River which has no nuclear operations associated with it.

27731 (DP-MS—80-21) **Ecological distribution of Legionella pneumophila.** Fliermans, C.B.; Cherry, W.B.; Orrison, L.H.; Smith, S.J.; Tison, D.L.; Pope, D.H. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.; Center for Disease Control, Altanta, GA (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Biology). 1980. Contract AC09-76SR00001. 37p. (CONF-800554—1). NTIS, PC A03/MF A01.

From American Society for Microbiology conference; Miami, FL, USA (11 May 1980).

Bacteria were concentrated 500-fold from 20-liter water samples collected from 67 different lakes and rivers in the United States. The data suggest that Legionella pneumophila is part of the natural aquatic environment, and that the bacterium is capable of surviving extreme ranges of environmental conditions. The data further demonstrate the effectiveness of the direct fluorescent antibody technique for detecting L. pneumophila in natural aquatic systems.

Smears of the concentrated samples were screened microscopically for the serogroups of L. pneumophilia by the direct fluorescent antibody (DFA) technique. Virtually all of the 793 samples were DFA-positive. Those samples (318) containing the largest numbers of DFA positive bacteria which were morphologically consistent with L. pneumophila were injected into guinea pigs for attempted isolations. Isolates were obtained from habitats with a wide range of physical, chemical, and biological parameters. Samples collected monthly from a thermally altered lake demonstrated a seasonality of guinea pig infection, with greatest infection occurring during the summer months.

27732 (ORNL/TM—7286, pp 7-37) **Studies at plant Bowen: rainfall modification and wetfall chemistry.** Patrinos, A.A.N.; Chen, N.C.J.; Miller, R.L.; Saylor, R.E. Apr 1980.

In Meteorological Effects of Thermal Energy Releases (METER) Program. Annual progress report, October 1978-September 1979.

The precipitation studies undertaken around the Bowen Electric Generating Plant have addressed two major areas during FY 1979. The first is the rainfall modification investigation and the second is the area of precipitation chemistry. The analysis of data from the METER-ORNL Network has revealed an effect of the power plant on the frequency of air mass storms in the vicinity of the plant. Precipitation chemistry data collected both on a weekly and a storm event basis have laid the groundwork for future wetfall chemistry studies and have shown some indication of a smokestack plume effect.

27733 **Modified venturi suction sampler for collecting Asiatic clams.** Mattice, J.S. (Oak Ridge National Lab., TN); Bosworth, W. Contract W-7405-ENG-26. *Prog. Fish-Cult.;* **41**: No. 3, 121-123(Jul 1979).

A device for collecting quantitative samples of the Asiatic clam, Corbicula sp., is described. The sampler is a modified venturi that is normally operated by a diver using scuba. Constriction of the water flow in the sampler supplies a pressure differential, causing water to be sucked in through a side arm. Water to operate the venturi is supplied by a gasoline-powered pump on a boat, and is conducted to the sampler by a flexible fire hose 7.6 cm (3 in.) in diameter. The sampler is constructed of polyvinylchloride. Suction lifts the substrate and associated clams from a sampling frame placed on the bottom and the main water stream carries the clams through a discharge arm to a mesh collection bag. The sampler is efficient in gravel or rocky substrates, is not depth-limited, is inexpensive and easy to construct, and permits collection of large samples (0.25 m^2). Its use permits the accurate density estimates required for population and community studies.

27734 **Climate and the ocean.** Newell, R.E. (Massachusetts Inst. of Technology, Cambridge). *Am. Sci.;* **67**: 405-416(Jul 1979).

Of the components of the terrestrial climate system, the oceans are clearly one of the most important. Because the specific heat per unit mass of water is about 4 times that of air, the thermal capacity of the oceans is over 1,000 times that of the atmosphere. In this paper I will stress the role of the oceans in regulating temperature and transporting energy in the climate system. In particular, since the temperature of the ocean surface is the variable most closely connected to the atmosphere, I will focus on the seasonal and nonseasonal variations in the top 100 m layer of water.

27735 **Fluctuations in zonal mean sea surface temperature.** Newell, R.E.; Hsiung, J. (Massachusetts Inst. of Tech., Cambridge). Contract-EY-78-S-02-2195.A004. *Riv. Ital. Geofis.;* 5: 151-155(1978).

There has been much discussion recently to the effect that climate is changing and that one reflection of this change is the occurrence of downward trends in sea surface temperature, a topic discussed by KUKLA et al. (1977) and REITER (1978). We have assembled a global collection of sea surface temperature data and present here the long-term zonal mean temperatures for each ocean and the deviations from these means since 1949.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 26923, 27710, 27712, 27720, 27728, 27730, 27747, 27922, 27924, 27975, 28002

27736 (ANL/EMR—5) **Bibliography of selected references on the effects of coal mine pollutants on aquatic ecosystems.** Daniels, T.F.; Daniels, L.K.; Olsen, R.D.; Johnson, D.O. (Argonne National Lab., IL (USA)). Dec 1979. Contract W-31-109-ENG-38. 258p. NTIS, PC A12/MF A01.

This bibliography contains more than 1400 references dealing with field and laboratory research on potential toxicities and disturbances known or postulated to be caused by pollutants found in coal mine effluents. The first of the three sections into which the bibliography is divided contains a select list of published bibliographies and literature reviews. In the second section are references on mine drainage studies, general references on environmental pollutants, and references dealing with two or more specific parameters. The third section includes references for 40 parameters under individual parameter headings. The multi parameter references in the second section are therefore also listed in the third section under individual headings. An author index is also provided.

27737 (CONF-800416—9) **Cooling tower windage: a new aspect to environmental assessment.** Taylor, F.G.; Park, S.H. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 17p. NTIS, PC A02/MF A01.

From UCC-ND and GAT waste management seminar program; Portsmouth, OH, USA (22 Apr 1980).

Results of the several investigations provided quantitative estimates of windage from Oak Ridge Gaseous Diffusion Plant cooling towers. Windage water deposited on the ground has the potential to reach nearby streams through runoff. Windage deposited on moisture depleted soils would not be significant. During winter months at Oak Ridge soils generally have a high moisture content such that windage deposition could be quickly transported as runoff. It is during this time that cooling towers are sometimes operated without fan-induced draft. Since windage water contains the same hexavalent chromium concentration (9 ppM) as the recirculating cooling water system, the runoff stream from the K-892J tower constitues a NPDES violation as an unpermitted discharge. As a long-term abatement strategy, concrete aprons were constructed along each side of new cooling towers at the Paducah, Kentucky Gaseous Diffusion Plant. The maximum distance of windage impact is wind dependent. If apron construction is envisioned as an abatement strategy at Oak Ridge, the maximum distance of impact can be inferred graphically from the several points where windage (fans off) and drift (fans on) loss curves intersect under the different meteorological conditions. Once the hexavalent chromium laden runoff stream reaches Poplar Creek, it is diluted well below the standards for drinking water and poses little potential for biological effects to aquatic systems.

27738 **Modification of trace element concentrations in natural waters by various field sampling techniques.** Owens, J.W.; Gladney, E.S.; Purtymun, W.D. (Los Alamos Scientific Lab., NM). *Anal. Lett.;* **13**: No. A4, 253-260(1980).

A study was undertaken to determine the effects of sample collection and preservation methods. Four different methods of sample collection and preservation are evaluated to determine effects on twenty-three different samples for eighteen dissolved inorganic species. Cleanliness and filtering apparatus had far more effect on the results than did the method of collection. The method recommended is for sample collection with minimum processing in the field, and expeditious return to the laboratory for filtering and acidification. 2 tables.

27739 **Role of volatilization in removing polycyclic aromatic hydrocarbons from aquatic environments.** Southworth, G.R. (Oak Ridge National Lab., TN). *Bull. Environ. Contam. Toxicol.;* **21**: 507-514(1979).

The movement of organic contaminants from water to the atmosphere can be important in reducing concentrations of foreign substances in aquatic ecosystems. Polycyclic aromatic hydrocarbons (PAH), a class of chemical produced in the combustion and pyrolysis of organic fuels, possess properties which suggest that their volatility in solution may be significant. Since many PAH are potent carcinogens, a knowledge of their persistence, transport, and fate in aquatic environments is critical. The objective of this paper is to determine the relative volatility of two to five ring PAH structures in water, and estimate the importance of the volatilization process in removing PAH from aquatic environments.

27740 **Adsorbent accumulation of organic pollutants for bioassays.** Glatz, B.A.; Chriswell, C.D.; Junk, G.A. (Iowa State Univ., Ames). *ACS Symp. Ser.;* No. 94, 91-100(1979).

The organic material accumulated from water and used for bioassays should be representative of that originally present in the water. As much unaltered material as possible should be accumulated. In this sense, the desire for effective accumulation is the same whether the organic mixture is to be separated for identification purposes or used directly for bioassays. The primary intent of this report is to describe some accumulation techniques which are applicable to bioassay requirements and to present preliminary results of bioassays performed on organic mixtures accumulated from drinking water.

27741 **Hydrocarbon budgets for Lake Washington.** Wakeham, S.G. (Univ. of Washington, Seattle). *Limnol. Oceanogr.;* **22**: No. 5, 952-957(Sep 1977).

Fluxes of hydrocarbons through Lake Washington show that urban stormwater runoff and river runoff are the major sources of petroleum hydrocarbons to the lake. Sedimentation is the primary removal process for these hydrocarbons.

27742 Characterization of the sources of petroleum hydrocarbons in Lake Washington. Wakeham, S.G. (Univ. of Washington, Seattle). *J. Water Pollut. Control Fed.;* 1680-1687(Jul 1977).

Surface sediments (0 to 20 mm) of Lake Washington (Wash.) have been found to contain high concentrations of hydrocarbons (up to about 1500 μg/g) compared to sediments at depth (> 300 mm) within the sediment column (~ 30 μg/g). Most of the hydrocarbons in surface sediments of the lake are believed to be derived from petroleum or its refined products as has been determined by gas chromatography and radiocarbon dating techniques, and by fluorescence spectroscopy. In contrast, those hydrocarbons in sediments deeper than about 300 mm appear to be derived primarily from terrestrial organic matter brought to the lake by rivers and streams, and the level of hydrocarbons in these sediments is thought to be the natural background level for Lake Washington. The presence of petroleum-derived hydrocarbons in the lake sediments correlates with the growth history of the metropolitan area surrounding Lake Washington, and it was thus of interest to survey the possible sources of this petroleum contamination to determine both the character of the sources and their relative importances.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 28002

27743 (FERMILAB—80/29) **Environmental monitoring report for calendar year 1979.** Baker, S.I. (Fermi National Accelerator Lab., Batavia, IL (USA)). 1 May 1980. Contract AI08-76DP00474. 38p. NTIS, PC A03/MF A01.

The accelerator operated routinely at 400 GeV during CY-1979 with about the same number of protons accelerated during CY-1979 as in CY-1978. The total number of protons accelerated in 1979 was 2.5 x 10^{19}. Typical operation was at about 40 percent of the design intensity of 5 x 10^{19} protons per acceleration cycle. During CY-1979 there were no abnormal ocurrences. The perforated tile field at BO was sealed off and a new resin regeneration system became operational. Precipitates from the effluent are disposed of as radioactive waste. There is no evidence for any off-site impact from previous releases of any pollutant. Operation of the Central Laboratory Sewage Treatment Plant was discontinued in June 1979, and sewage was diverted to the City of Batavia Sewage Treatment Plant. The maximum potential radiation exposure at the site boundary during CY-1979 was 2 mrem compared to 11 mrem last year. This dose rate was lower because the experimental areas produced fewer off-site muons this year. The total potential radiation exposure to the general off-site population from Fermilab operations during CY-1979 was 3 man-rem compared to 5 man-rem last year. Airborne radioactivity was released across the site boundary in small amounts throughout the year. The radioactive gas was primarily ^{11}C, total quantity released was 4 kCi, and the maximum dose at the site boundary was 1.0 mrem for 1979. The average concentration at site boundary based on measurements at the stack was 0.2% of the Concentration Guide. There was also a controlled release of tritium; the total amount released was 280 mCi. Tritium was released continuously from about June 1, 1979 (when the Meson Area resumed operations after a long shutdown) until the end of the year. The average concentration at the site boundary was about 0.00001% of the Concentration Guide, resulting in a negligible off-site exposure.

WATER

REFER ALSO TO CITATION(S) 26993, 27011, 27692, 27718, 27883, 27993

27744 (CONF-800433—4) **Autoradiographic studies of actinide sorption in groundwater systems.** O'Kelley, G.D.; Beall, G.W.; Allard, B. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 9p. NTIS, PC A02/MF A01.

From 4. international conference on nuclear methods in environment and energy research; Columbia, MO, USA (14 Apr 1980).

Autoradiography is a convenient and sensitive technique for the study of spacial distributions of alpha radioactive nuclides on slabs of rock or on other planar surfaces. The autoradiographic camera contains an arrangement for placing in firm contact Polaroid sheet film, a plastic scintillator screen, and the radioactive face of the specimen. As an example of the use of the autoradiographic method, a series of sorption experiments were carried out in which synthetic groundwater solutions of americium, neptunium, uranium, and plutonium were contacted with Climax Stock granite under aerated and anoxic conditions at pH 8 to 9. The sorption observed at specific mineral sites was correlated with data on sorption of these actinides on pure minerals.

27745 (PNL—3346) **Radiological status of the ground water beneath the Hanford project, January-December 1979.** Eddy, P.A.; Wilbur, J.S. (Battelle Columbus Labs., OH (USA)). Apr 1980. Contract AC06-76RL01830. 114p. NTIS, PC A06/MF A01.

Operations on the Hanford Site since 1944 have resulted in discharge of large volumes of process cooling water and low-level liquid radioactive waste to the ground. Radioactivity and chemical substances have been carried with these discharges and have reached the Hanford ground water. For may years wells have been used as groundwater sampling structures to gather data on the distribution and movement of these discharges as they interact with the unconfined ground water beneath the site. During 1979, 317 wells were sampled on various frequencies from weekly to annually. This report is one of a series prepared annually to document the evaluation of the status of ground water on the Hanford Site. Data collected during 1979 describe the movement of radionuclide (Tritium and Beta) and nitrate plumes that respond to the influence of groundwater flow, ionic dispersion and radioactive decay.

27746 (RFP—3005) **Plutonium decontamination studies using Reverse Osmosis.** Plock, C.E.; Travis, T.N. (Rockwell International Corp., Canoga Park, CA (USA). Energy Systems Group). 17 Jun 1980. Contract AC04-76DP03533. 7p. NTIS, PC A02/MF A01.

Water in batches of 45 gallons each, from a creek crossing the Rocky Flats Plant, was transferred to the Reverse Osmosis (RO) laboratory for experimental testing. The testing involved using RO for plutonium decontamination. For each test, the water was spiked with plutonium, had its pH adjusted, and was then processed by RO. At a water recovery level of 87%, the plutonium decontamination factors ranged from near 100 to 1200, depending on the pH of the processed water.

AQUATIC ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 26998, 27694, 27722, 27723, 27926

27747 (IS—4741) **Multilaboratory analytical quality control for the hydrogeochemical and stream sediment reconnaissance. Quality control report for March 1980.** D'Silva, A.P.; Grabau, F.; Haas, W.J. Jr. (Ames Lab., IA (USA)). May 1980. Contract W-7405-ENG-82. 105p. NTIS, PC A06/MF A01.

During this period SRL reported multielement results for Sediments R3, S3, and T1 as requested. These values include analysis results for Al, Ce, Cl, Eu, Fe, Hf, La, Lu, Mn, Na, Sc, Sm, Th, Ti, V, and Yb in addition to U. These results were combined with previously reported multielement results and are presented in this report.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 27911, 27994

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 27366

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 27267

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 27267

27748 Atmospheric stability comparisons at shore and inalnd sites. Brown, R.M.; SethuRaman, S.; Nagle, C. (Brookhaven National Lab., Upton, NY). Contract EY-76-C-02-0016. pp 27-29 of Second conference on coastal meteorology. Boston, MA; American Meteorological Society (1980).

From 2. conference on coastal meteorology; Los Angeles, CA (30 Jan 1980).

Coastal zones provide ideal locations for a multitude of industrial complexes and power plants due to their access to transportation and cooling water. Engineering feasibility studies on plant design for proposed coastal sites are often inolved with determining pollution factors associated with various locations. The standard

atmospheric diffusion equations and models include some form of atmospheric stability to arrive at downwind concentration values. The values needed to predict diffusion and resulting concentrations from sources near coastlines is limited by lack of experimental data at coastal locations. The results obtained in this study are directed to assist in those calculations. They were determined as a by-product of a research program underway at Brookhaven National Laboratory designed to determine atmospheric diffusion properties at a coastal site. Raynor et al. provides documentation of the initial phases of the program and Raynor et al. amplifies on the most recent experiments undertaken in this project. This paper deals with the wind measurements made at the coastal site and some comparisons with the measurements made at an inland location.

27749 Recommended changes in meteorological measurement and prediction methods for coastal sites. Raynor, G.S.; Michael, P.; SethuRaman, S. (Brookhaven National Lab., Upton, NY). Contract EY-76-C-02-0016. pp 22-26 of Second conference on coastal meteorology. Boston, MA; American Meteorological Society (1980).

From 2. conference on coastal meteorology; Los Angeles, CA (30 Jan 1980).

A study was performed at the request of the US Nuclear Regulatory Commission (NRC) to examine currently recommended meteorological measurement programs and atmospheric transport and diffusion prediction models for nuclear power plants to determine their adequacy for plants located in coastal zones where meteorological conditions are normally more complex than at inland sites and to make recommendations for changes to improve current procedures. Recommendations were based on an extensive literature review and on studies of coastal meteorology and diffusion made at Brookhaven National Laboratory since 1972. An earlier review of the effects on atmospheric diffusion of meteorological processes in coastal zones was presented by Raynor.

27750 Climatology of internal gravity waves in the marine surface layer in a coastal environment. SethuRaman, S.; Nagle, C.; Raynor, G.S. (Brookhaven National Lab., Upton, NY). Contract EY-76-C-02-0016. pp 244-246 of Second conference on coastal meteorology. Boston, MA; American Meteorological Society (1980).

From 2. conference on coastal meteorology; Los Angeles, CA (30 Jan 1980).

Formation of stable atmospheric layers often leads to the generation and propagation of internal gravity waves. Instability of these waves causes breaking and enhanced turbulence. Wave-breaking in upper layers of the atmosphere leads to clear air turbulence (CAT), a phenomenon extensively investigated. Internal waves could also occur near the earth's surface within the atmospheric boundary layer when stable atmospheric conditions prevail. In such cases, internal waves coexist with turbulence caused by mechanical roughness for moderate stabilities. Enhancement of turbulence occurs when the waves break. Occurrence of the waves in the boundary layer significantly modifies the diffusion characteristics of the atmosphere since waves are known to transport rather than diffuse momentum and heat. Restricting ourselves to the atmospheric surface layer, a layer within the first 100 m above the surface, waves occur over land mostly with nocturnal inversions. But, over coastal waters, stable atmosphericc conditions conductive to the formation of internal waves can occur at any time of the day due to the thermal inertia of large bodies of water. The purpose of this paper is to discuss the climatological variations of the occurrence of internal gravity wave events at a coastal site as compared with an inland site, and possible reasons for the differences.

27751 Transport and diffusion climatology of the US Atlantic and Gulf Coasts. Raynor, G.S.; Hayes, J.V. (Brookhaven National Lab., Upton, NY). Contract EY-76-C-02-0016. pp 30-33 of Second conference on coastal meteorology. Boston, MA; American Meteorological Society (1980).

From 2. conference on coastal meteorology; Los Angeles, CA (30 Jan 1980).

This study is part of a larger study of coastal meteorology and diffusion and was planned to assist in site selection by describing the transport and diffusion climatology of the United States east and Gulf coasts in as much detail as can be extracted from readily available meteorological data. Site specific studies may still be necessary for particular locations but the information presented may be adequate to guide a choice between potential sites with respect to air pollution transport and diffusion. No consideration was given in this study to other environmental, economic or political conditions that may also be important in site selection although a planned extension of this study will rate each section of coastline for severe weather potential. The effects on atmospheric diffusion of meteorological processes in coastal zones were discussed previously. A prior presentation briefly described this study and presented some preliminary results. Complete results are given in a more recent report.

27752 Land-use conflicts with natural vegetation in the United States. Klopatek, J.M. (Oak Ridge National Lab., TN); Olson, R.J.; Emerson, C.J.; Joness, J.L. *Environ. Conserv.;* **6**: No. 3, 191-200(Aut 1979).

The need to interpret information on land-use and vegetation prompted the use of extant data in order to determine the amounts and types of vegetation existing within the United States. The preservation of natural vegetation is an integral part of the US Forest Service's Roadless Area Review and Evaluation program (RARE-II). This program allocates roadless areas to wilderness as part of the National Wilderness Preservation System, or to other land-uses based on many criteria. In an ecological analysis of identified RARE-II tracts, estimates and spatial distributions of natural vegetation types adjusted for current land-use was developed. The area of a particular vegetation type occurring on a RARE-II tract was compared with the estimate of the amount of that vegetation type which currently occurs in the United States. This measure of vegetation uniqueness was one of several devices employed to identify ecologically similar tracts which could be used to resolve land-use conflicts while preserving representative vegetation. The results of this study indicate that each of 23 of the 106 vegetation types occurring in the continental United States have been reduced by more than 50% through Man-induced land-use changes. In contrast, only 26 types have had 5% or less of their potential area converted to urban, agricultural, pasture, or other miscellaneous uses.

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 27708, 27752, 27808, 27861, 27945

27753 (DOE/EV/71005—51) Coninuous migration model with stable demography. Sawyer, S.; Felsenstein, J. (Washington Univ., Seattle (USA)). 1980. Contract AT06-76EV71005. 25p. (RLO—2225-5-51). NTIS, PC A02/MF A01.

A probability model of a population undergoing migration, mutation, and mating in a geographic continuum R is constructed, and an integro-differential equation is derived for the probability of genetic identity. The equation is solved in one case, and asymptotic analysis done in others. Individuals at x,y ϵ R in the model mate with probability V(x,y)dt in any time interval (t,t+dt). In two dimensions, if V(x,y) = V(x-y) where V(x) $\approx$ V(x/β)/β^2 approaches a delta function, the equilibrium probability of identity vanishes as $\beta \rightarrow 0$. The asymptotic rate at which this occurs is found for mutation rates u identical with $u_0 > 0$ and for $\beta \approx$ Cu/sub α/, $\alpha > 0$, and $u \rightarrow 0$.

27754 Weight dependence of net growth efficiency and specific respiration rates among field populations of invertebrates. Banse, K. (Univ. of Washington, Seattle). *Oecologia (Berlin);* **38**: 111-126(1979).

Annual net growth efficiency (NGE) is approximated here by 100 P/sub a//(P/sub a/ + R/sub a/), P/sub a/ and R/sub a/ being the annual production and respiration rates of populations per unit area. Published NGE values for 15 temperate invertebrate populations range from 13 to 55%. Contrary to the literature on NGE among species, the dependence of NGE on species size (as body weight at the onset of sexual maturity, W/sub s/) is not yet determined although the ranges of P/sub a/ and R/sub a/, divided by the mean biomass (B), approach two orders of magnitude. The R/sub a//B rates of 13 of these populations decline with a -0.35 power of W/sub s/ rather than the -0.25 power of comparative physiology. A possible reason may be a trend towards larger specimens (relative to W/sub s/ or full size) in populations of larger species. Among species, a significant dependence of NGE on W/sub s/ (or full size) is not demonstrable for laboratory populations of unicellular organisms and field populations of mammals so that the cost per unit of production might generally be independent of the rate of production by the population.

27755 Response of mule deer to tape recorded fawn distress calls. *Wildlife Soc. Bull.;* **6**: No. 3, 169-170(Fal 1978).

Diem (J. Wildl. Manage. 18[4]:537-538, 1954) used an artificial deer call imitating a bleating fawn to determine if does had young nearby. White et al. (J. Wildl. Manage. 36[3]:897-906, 1972) observed that a bleating fawn often attracted other deer, especially dams. We attempted to use tape-recorded calls for location of Rocky Mountain mule deer (Odocoileus hemionus hemionus) fawns from 10 June to 1 August 1976 as part of a deer population dynamics and movement study at Rocky Flats, Colorado. This article presents results of observations made on deer after playing fawn distress calls and discusses the effectiveness of this technique in locating mule deer fawns.

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 27057, 27796, 27798, 27800, 27801, 27803, 27807, 27809, 27816, 27823, 27827, 27828, 27829, 27830, 27831, 27832, 27834, 27835, 27855, 27916, 27917, 27918, 27925, 27938, 27946, 27957, 27979, 27983

27756 (COO—3162-51) **[Structure and function in photosynthetic membranes and their components]. Annual progress report, December 1, 1978-November 30, 1979.** Clayton, R.K. (Cornell Univ., Ithaca, NY (USA)). 1979. Contract EY-76-S-02-3162. 16p. NTIS, PC A02/MF A01.

Structure and function are being studied in photosynthetic membranes and their components, principally with Rhodopseudomonas sphaeroides. That bacteriochlorophyll (Bchl) can have a strongly shifted absorption maximum in the membrane, without the involvement of excitonic Bchl-Bchl interactions was demonstrated. The orientations of pigments in the membrane are being determined, and the orientations of four distinguishable carotenoid components are under investigation. These studies provide data for computations of energy transfer and electron tunneling, and may bear on the mechanism of the electrogenic shifts of the absorption bands of carotenoids. New complexities in the absorption spectra of cytochromes were discovered, and new data concerning the distribution of carotenoids between antenna and reaction centers (RCs) in the membrane, and possible differences in their isomeric configuration were obtained. Antenna pigment-protein complexes and mutant phenotypes obtained elsewhere have been characterized. A corrected interpretation of the action of orthophenanthroline as an inhibitor of electron transport was presented. Analyses of RCs from Rp. viridis raised the possibility that the bound cytochromes Cyt 552 and Cyt 558 might consist of hemes attached to the RC protein. In collaboration with researchers at Harvard, an unusual temperature dependence for photoconversion of allophycocyanin isolated from cyanobacteria (blue-green algae) was found that has led to a stringent test of whether the photoconvertible allophycocyanin mediates chromatic adaptation in these organisms. Some theoretical studies of the problems that may arise in constructing solar cells from natural or artificial RCs have been conducted. (ERB)

27757 (PNL—3300(Pt.1), pp 263-265) **Partial purification of exocellular acid proteases induced from Neurospora crassa.** Rhodes, W.G.; Eirich, L.D.; Lindberg, R.A.; Drucker, H. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

A pepstatin-inhibitable acid protease and a metalloprotease of acid pH optima were partially resolved from exocellular filtrate of N. crassa cultures induced for protease biosynthesis under conditions of nitrogen starvation, with protein as sole source of nitrogen.

27758 (PNL—3300(Pt.1), pp 266-269) **Regulation in Neurospora crassa of an induced exocellular acid protease.** Lindberg, R.A.; Rhodes, W.G.; Eirich, L.D.; Drucker, H. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

We examined regulation of exocellular acid proteases induced from N. crassa grown on protein as sole source of C, N, or S. Type of acid protease synthesized appeared to be a function of conditions of induction, with metalloproteases of acid pH optima produced under conditions of N- or C-starvation; and a true acid protease, inhibitable by pepstatin, produced under conditions of S-starvation. The data suggest that unique sequences of N. crassa's genome may be expressed as a function of induction, and that there may be different pathways for expression of exocellular protease genes, varying with exocellular milieu.

27759 (PNL—3300(Pt.1), pp 270-271) **Further characterization of Neurospora crassa exocellular alkaline protease.** Eirich, L.D.; Lindberg, R.A.; Drucker, H. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Temperature optima, thermal stability, and pH optima were determined for the purified exocellular alkaline protease of N. crassa. Molecular weight was determined by hydrodynamic means and compared with molecular weight ascertained by other methods.

27760 Structural comparison of several actin-binding macromolecules. Tyler, J.M.; Anderson, J.M.; Branton, D. (Harvard Univ., Cambridge, MA). *J. Cell Biol.;* **85**: No. 2, 489-495(May 1980).

The cytoskeletal components, macrophage actin-binding protein and filamin were dried from glycerol and examined by low-angle rotary shadowing electron microscopy. Both are elongate, flexible molecules whose general morphology is similar to that of erythrocyte spectrin. Neither actin-binding protein nor filamin binds to spectrin-depleted erythrocyte membranes.

27761 Action spectra determined with tunable dye laser light for light-induced proton efflux and uptake in membrane vesicles of Halobacterium halobium. Greene, R.V. (Cornell Univ., Ithaca, NY); MacDonald, R.E.; Perrault, G.J. *J. Biol. Chem.;* **255**: No. 8, 3245-3247(25 Apr 1980).

A new pigment from Halobacterium halobium has been previously described which mediates the electrogenic extrusion of sodium ions when illuminated. Using essentially monochromatic light (0.05 nm bandwidth), maximum activity for this pigment occurred at 590 nm as monitored by passive proton uptake in envelope vesicles. The uncoupler bis(hexafluoroacetonyl)-acetone did not shift peak activity, but did increase passive proton influx. When the new pigment (NaP_{590}) and bacteriorhodopsin, the well characterized proton pump, were compared at their respective wavelengths of maximum activity, NaP_{590} required approximately 100-fold more energy to achieve saturation.

27762 Suppression of cytidylate biosynthesis by protein synthesis antagonists. Pike, L.M.; Khym, J.X.; Jones, M.H.; Lee, W.H.; Volkin, E. (East Tennessee State Univ., Johnson City). Contract W-7405-ENG-26. *J. Biol. Chem.;* **255**: No. 8, 3340-3347(25 Apr 1980).

When protein synthesis is effectively inhibited in Novikoff cell cultures by various drugs, there is a marked suppression of labeling of cytidiane nucleotides (mainly CTP) from exogenously supplied [^{3}H]uridine. The inhibition could be caused by a reduced activity of CTP synthetase, the enzyme catalyzing the conversion of UTP to CTP, since [^{3}H]UTP is readily produced. The variety of the drugs used appears to argue against a direct effect of the drugs on CTP synthetase, since three different glutarimide antibiotics (cycloheximide, streptimidone, and emetine) and puromycin, which has a quite different chemical structure, are equally effective. An increase of the cytidine nucleotide pool size is observed in most instances of drug treatment; however, feedback inhibition of CTP synthetase is considered unlikely because of a lack of correlation between the degree of inhibition of [^{3}H]CTP production and the extent of accumulation of the cytidine nucleotides. There is a marked inhibition of RNA synthesis when all protein synthesis inhibitors are present; but almost complete inhibition of RNA synthesis by actinomycin D produces only a slight inhibition in [^{3}H]CTP production, indicating that the block in the conversion of UTP to CTP results from inhibited protein synthesis rather than from inhibited RNA synthesis. Examination of the labeling pattern of both RNA and DNA nucleotides following drug treatment gave further evidence for inhibited CTP production. Inhibition of protein synthesis elicited a much greater reduction of the suppression ratio (experimental/control ratio) for RNA-CMP labeling than for RNA-UMP labeling and an even greater reduction of the suppression ratio for DNA-dCMP labeling compared to DNA-dTMP labeling. The effect was also obtained in HeLa cell cultures, but is not restricted to neoplastic cell lines since it was seen with normal human diploid fibroblast cultures.

27763 Purification and characterization of a Saccharomyces cerevisiae exoribonuclease which yields 5′-mononucleotides by a 5′ → 3′ mode of hydrolysis. Stevens, A. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *J. Biol. Chem.;* **255**: No. 7, 3080-3085(10 Apr 1980).

An exoribonuclease producing 5′-mononucleotides has been purified from ribosomes of Saccharomyces cerevisiae. The enzyme has a broad pH optimum around 8.0, requires divalent cation, and is stimulated by monovalent cation with the cation and degree of stimulation being dependent on the substrate used. With either poly(a) or rRNA as substrate, the enzyme has a processive mode of hydrolysis. The oligonucleotides, (pA)/sub 3-5/, are hydrolyzed by the enzyme, and the hydrolysis is dependent on a 5′-phosphate end group. Phosphorylation of the 3′ end has little effect on the rate of hydrolysis. With [^{3}H]poly(A) or [^{3}H]rRNA, labeled differentially at the 5′ termini, a more rapid release of 5′-terminal label can be shown, providing evidence that the enzyme hydrolyzes in a 5′ → 3′ direction. Further evidence for a 5′ → 3′ mode of hydrolysis is provided by a study of the products of the hydrolysis of [^{3}H](pA)$_5$ labeled at the 5′ termini with ^{32}P. No ^{32}P label is found in (pA)$_2$ which accumulates as an intermediate.

27764 Effects of permeant buffers on the initial time course of photophosphorylation and postillumination phosphorylation. Vinkler, C.; Avron, M.; Boyer, P.D. (Univ. of California, Los Angeles). *J. Biol. Chem.;* **255**: No. 6, 2263-2266(25 Mar 1980).

Permeant buffers (pyridine, imidazole, or phosphate) caused similar increases in the time required for onset of ATP synthesis in the light in the presence of valinomycin and K+; and in the illumination time required for postillumination phosphorylation with or without valinomycin and K+. Based on prior evidence, the minimum illumination time required for postillumination phosphorylation in thylakoid membranes is taken as a measure of the time required for formation of a transmembrane pH gradient sufficient to drive ATP synthesis. Our results are consistent with the view that, following illumination, as the transient transmembrane electric gradient decays, the establishment and maintenance of a pH gradient

serve for energy transfer from the photosystems to the ATP synthase complex.

27765 Reaction of the 7,8-diol 9,10-epoxide of benzo[a]pyrene with guanine in DNA. Ab initio calculations and proposed reaction mechanism. Lin, J. (Univ. of Illinois, Chicago); LeBreton, P.R.; Shipman, L.L. *J. Phys. Chem.;* **84**: No. 6, 642-649(20 Mar 1980).

The molecular fragment floating spherical Gaussian orbital method has been used to study model complexes related to the reaction between 7β,8α-dihydroxy-7,8,9,10-tetrahydrobenzo[a]pyrene 9α,10α-oxide and guanine in DNA. The results of these calculations in combination with previous theoretical and experimental results suggest that the reaction proceeds via a three-step mechanism: (1) formation of a physical complex in which the pyrene moiety of the diol epoxide intercalates between base pairs of DNA and the reduced hydrophilic ring extends outside the helix into solution; (2) acid-catalyzed epoxide ring opening to form the 7,8,9-triol carbonium ion; and (3) formation of a C_{10}-N_2 covalent bond and deprotonation of N_2 to form the experimentally observed covalently linked product.

27766 Epidermal growth factor induces tyrosine hydroxylase in a clonal pheochromocytoma cell line, PC-G2. Goodman, R.; Slater, E.; Herschman, H.R. (Univ. of California, Los Angeles). *J. Cell Biol.;* **84**: No. 3, 495-500(Mar 1980).

We have previously described the isolation of a clonal cell line (PC-G2) in which the level of tyrosine hydroxylase (TH), the rate-limiting step in the synthesis of the catecholamine neurotransmitters, is induced by nerve growth factor (NGF). We now report that epidermal growth factor (EGF) also induces TH in the PC-G2 cell line. Although EFG has been shown to be mitogenic for many cultured cells, no neuronal function has been previously reported for this protein. The TH response to EGF is elicited in a dose-dependent fashion at concentrations as low as 0.1 ng/ml and is maximal at 10 ng/ml EGF. The maximal response is observed after 3 to 4 d of exposure to 10 ng/ml EGF. The induction by NGF and EGF is inhibited by their respective antisera. Dexamethasone, a synthetic glucocorticoid which we have previously shown modulates the response of PC-G2 cells to NGF, also modulates the TH induction elicited by EGF.

27767 Self-association of human immunoglobulin kI light chains: role of the third hypervariable region. Stevens, F.J. (Argonne National Lab., IL); Westholm, F.A.; Solomon, A.; Schiffer, M. Contract W-31-109-ENG-38. *Proc. Natl. Acad. Sci. U.S.A.;* **77**: No. 2, 1144-1148(Feb 1980).

Gel electrophoresis and molecular sieve chromatography were used to compare 17 different human kI type Bence Jones proteins including 5 for which the amino acid sequence is known. Although electrophoresis in the presence of $NaDodSO_4$ showed uniformity of covalent dimer and monomer molecular weights, Sephadex chromatography under nondissociating conditions showed that monomers eluted with different apparent molecular weights. These differences were attributed to heterogeneity in light chain self-association; dimerization constants of the 17 proteins, calculated from a computer simulation of their behavior upon gel filtration, ranged from $< 10^3$ to $> 10^6 M^{-1}$. The variable region, more specifically the third hypervariable region, appears to be responsible for the variation in the dimerization constant. Association properties of light chains of known sequence suggest that the presence of an aromatic or hydrophobic residue at position 96 enhances dimer formation whereas a change residue at that position results in light chains remaining stable monomers. The location of hypervariable residue 96 within the amino-terminal portion of the joining segment of the variable region suggests that the joining region may account for the variability of selfassociation of light chains and, moreover, that it has a function in determining the selective association of immunoglobulin polypeptide chains.

27768 Regulation of mitochondrial malic enzyme synthesis in mouse brain. Bernstine, E.G.; Koh, C.; Lovelace, C.C. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 12, 6539-6541(Dec 1979).

In a previous study it was shown that inbred strains of mice fall into two classes based on the specific activity of mitochondrial malic enzyme [L-malate:$NADP^+$ oxidoreductase (oxaloacetate-decarboxylating), EC 1.1.1.40] in brain. In this report we demonstrate differences between high- and low-activity strains in the development of enzyme activity levels in adult mice and show that the rate of enzyme synthesis quantitatively accounts for the inherited level of the brain enzyme. Genetic analysis has established that the locus controlling the amount of enzyme in brain (Mdr-I) is located on chromosome 7. Its linkage to Hbb and c places it in the same region of the chromosome as Mod-2, the structural gene for mitochondrial malic enzyme. By making use of deletions and a duplication that include Mod-2, evidence for cis action of Mdr-1 was obtained.

27769 Dense (aged) circulating red cells contain normal concentrations of adenosine triphosphate (ATP). Kirkpatrick, F.H.; Muhs, A.G.; Kostuk, R.K.; Gabel, C.W. *Blood;* **54**: No. 4, 946-950(Oct 1979).

The densest 0.1% to 1% of circulating red cells were separated from fresh blood, and the ATP content of a representative sample of such cells was determined. The dense (old) cells had decreased amounts of ATP relative to unfractionated cells. However, the dense cells were also smaller, and the concentration of ATP in these cells was the same as in controls. Therefore, it seems unlikely that loss of cellular ATP is a causative factor in removal of senescent red cells from the circulation.

27770 Electron spin resonance study of the role of NO.catalase in the activation of guanylate cyclase by NaN_3 and NH_2OH. Craven, P.A.; DeRubertis, F.R.; Pratt, D.W. (Univ. of Pittsburgh, PA). Contract EY-76-S-02-3435. *J. Biol. Chem.;* **254**: No. 17, 8213-8221(10 Sep 1979).

The role of NO.catalase in the activation of partially purified soluble guanylate cyclase of rat liver by NaN_3 and NH_2OH was examined by electron spin resonance (ESR) spectroscopy. The stimulation of partially purified guanylate cyclase by NO.catalase was similar to that obtained with NO.hemeoglobin and with NO.cytochrome P-420. By contrast, these same enzyme preparations did not respond to NO or catalase alone. Addition of hematin or hemoglobin plus a reducing agent to purified guanylate cyclase restored enzyme responsiveness to NO and N-methyl-N'-nitro-N-nitro-soguanidine (MNNG), but not to NaN_3 or NH_2OH. Formation of the NO.catalase complex was evident by ESR spectroscopy in test solutions containing NaN_3 or NH_2OH, catalase, and a glucose-glucose oxidase, H_2O_2-generating system. These results provide evidence for catalase-dependent NO generation from NaN_3 and NH_2OH under conditions leading to guanylate cyclase activation. Preformed NO.hemoglobin or NO.cytochrome P-420 also activated heme-deficient partially purified guanylate cyclase. In the absence of the NO ligand, both hemoglobin and catalase suppress the stimulatory effects of the corresponding NO.heme proteins on guanylate cyclase. However, hemoglobin is approximately 2000 times more effective as an inhibitor of NO.hemoglobin stimulation of guanylate cyclase than is catalase as an inhibitor of NO.catalase action.The results imply that guanylate cyclase responses to activators that can form NO are determined by both the stimulatory activity of the endogenous heme acceptors of NO and the relative inhibitory effects of the unliganded heme proteins present. (DS)

27771 Structural and regulatory properties of pyruvate kinase from Pseudomonas citronellolis. Chuang, D.T.; Utter, M.F. (Case Western Reserve Univ., Cleveland, OH). Contract AT-(11-1)-1242. *J. Biol. Chem.;* **254**: No. 17, 8434-8441(10 Sep 1979).

Pseudomonas citronellolis contains a single variety of pyruvate kinase regardless of the substrate on which the organism is grown. The enzyme has been purified to homogeneity and shown by cross-linking and gel electrophoretic studies to be a tetramer of M/ sub r/ = 225,000 to 240,000. Unlike pyruvate kinases from yeast, liver, kidney, and red cells, the Pseudomonas enzyme is not affected by fructose 1,6-bisphosphate. However, it is activated by 2-keto-3-deoxy-6-phosphogluconate (KDPG), an intermediate of the Entner-Doudoroff pathway which is utilized for glucose catabolism by this organism. The Pseudomonas enzyme is also activated by ribose-5-P,5'-AMP, and fructose-6-P. Kinetic studies suggest that this group of metabolites may act at a single site with KDPG activation occurring at a separate site. All of the activators function by increasing the affinity of the enzyme for P-enolpyruvate. The latter substrate shows a strong positive cooperativity with the enzyme which is lowered or abolished by the presence of the activators. A strong synergistic effect exists between KDPG and ribose-5-P as exhibited by a mutual lowering of the concentrations required for activation as well as by a more than additive effect on the enzyme's affinity for P-enolpyruvate. Pyruvate kinase from P. citronellolis also differs from most varieties of the enzyme in that it is not activated by K^+ orNH_4^+, requires high concentrations of Mg^{2+} and is relatively nonspecific with respect to its nucleoside diphosphate substrate.

27772 Subcellular site and mechanism of synthesis of disaturated phosphatidylcholine in alveolar type II cell adenomas. Voelker, D.R.; Snyder, F. (Oak Ridge Associated Universities, TN). Contract EY-76-C-05-0033. *J. Biol. Chem.;* **254**: No. 17, 8628-8633(10 Sep 1979).

The site of synthesis of 1,2-disaturated-(diacyl)-sn-glycero-3-phosphocholine (Sat_2PC) in mouse alveolar type II cell adenomas has been studied by conducting pulse-chase experiments. Isolation of microsomal and lamellar body fractions from adenomas after a 20-min pulse with [methyl-^{3}H]choline demonstrates that Sat_2PC first appears in the microsomal fraction, and after a short lag subsequently appears in the lamellar body fraction. The kinetics of labeling of Sat_2PC are consistent with the microsomal membranes functioning as the subcellular site of synthesis for this pulmonary surfactant phospholipid. Short term labeling experiments with [9,10-^{3}H]palmitate demonstrate that this fatty acid is incorporated into the sn-2 position of Sat_2PC at a faster rate than its incorporation into the sn-1 position. This finding indicates that the synthesis of Sat_2PC occurs by a deacylation-reacylation mechanism.

27773 Modulation of the action of the recBC enzyme of Escherichia coli K-12 by Ca^{2+}. Rosamond, J.; Telander, K.M.; Linn, S. (Univ. of California, Berkeley). Contract EY-76-5-03-0034. *J. Biol. Chem.;* **254**: No. 17, 8646-8652(10 Sep 1979).

The various activities of the recBC enzyme of Escherichia coli are differentially sensitive to reaction conditions. Although spermidine up to 50 mM and putrescine up to 40 mM in the presence of Mg^{2+} produce no significant alteration in the activities of the enzyme, low concentrations of Ca^{2+} have a dramatic effect. In the presence of 1 mM Ca^{2+}, 1 mM Mg^{2+}, and 5 mM ATP, the DNA-dependent ATPase is unaffected, but the double strand DNA exonuclease and the single strand DNA exonuclease and endonuclease activities are completely inhibited. Duplex phage T7 DNA which has been exposed to enzyme under these conditions remains wholly duplex and full length, although about 5 nicks are made randomly in each duplex. When DNA binding protein from E. coli is included in the reaction with enzyme and DNA, the products are, at early stages of the reaction, duplex DNA molecules with one or two single-stranded tails at a terminus; after prolonged incubation, solely single-stranded fragments of 5000 to 35,000 nucleotides are found. (Full length strands are roughly 40,000 nucleotides long.) These products can be rationalized by a model in which the enzyme binds initially to the terminus of a duplex DNA molecule and then tracks along the DNA, unwinding the strands of the helix as it moves. This denaturation would be transient and localized around the enzyme molecule so that the DNA would renature after the enzyme has passed through a particular region. However, the renaturation can be prevented by the presence of DNA binding protein during the reaction. During the passage of an enzyme molecule through a DNA molecule, a limited number of nicks are randomly introduced in a manner essentially unaffected by binding protein. This mode of action is distinct from that observed for the degradation of duplex DNA with Mg^{2+} but not Ca^{2+} present.

27774 Photosensitized electron transport across lipid vesicle walls: quantum yield dependence on sensitizer concentration. Ford, W.E.; Otvos, J.W.; Calvin, M. (Univ. of California, Berkeley). Contract W-7405-ENG-48. *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 8, 3590-3593(Aug 1979).

An amphiphilic tris(2,2'-bipyridine)ruthenium(2+) derivative that is incorporated into the walls of phosphatidylcholine vesicles photosensitizes the irreversible oxidation of ethylenediaminetetraacetate(3-) dissolved in the inner aqueous compartments of the vesicle suspension and the one-electron reduction of heptylviologen(2+) dissolved in the continuous aqueous phase. The quantum yield of viologen radical production depends on the phospholipid-to-ruthenium complex mole ratio. A kinetic model is used to derive an order-of-magnitude estimate for the rate constant of electron transport across the vesicle walls. The results are inconsistent with a diffusional mechanism for electron transport and are interpreted in terms of electron exchange.

27775 Red cell proteins. I. Two-dimensional mapping of human erythrocyte lysate proteins. Edwards, J.J.; Anderson, N.G.; Nance, S.L.; Anderson, N.L. (Argonne National Lab., IL). *Blood;* **53**: No. 6, 1121-1132(Jun 1979).

Human erythrocyte lysate proteins were resolved into over 250 discrete spots by two-dimensional electrophoresis using isoelectric focusing in the first dimension and electrophoresis in the presence of sodium dodecyl sulfate (SDS) in the second. The overwhelming excess of hemoglobin has made such analyses difficult in the past. However, with the ISO-DALT two-dimensional electrophoresis system, large numbers of red cell proteins can be mapped in the presence of hemoglobin. When hemoglobin and several other major proteins are removed by adsorption to DEAE-cellulose, additional minor components are seen, giving a total of over 275. With the use of purified preparations, the map positions of five red cell enzymes or their subunits were determined: pyruvate kinase, catalase, glucose-6-phosphate dehydrogenase, hypoxanthine phosphoribosyltransferase, and carbonic anhydrase. The mapping techniques described complement and extend those traditionally used to find human red cell protein variants.

27776 Apolipoprotein A-II and structure of human serum high density lipoproteins. Ritter, M.C.; Scanu, A.M. (Univ. of Chicago, IL). Contract EY-76-C-02-0069. *J. Biol. Chem.;* **254**: No. 7, 2517-2525(10 Apr 1979).

The results indicate that (a) apo-A-II can generate HDL complexes, although these are heterogeneous in size and density; (b) the formation of these complexes requires well defined conditions, particularly with regard to initial protein concentration and lipid/protein ratio; (c) below and above the optimal apo-A-II concentration for HDL reassembly, reassociation of apo-A-II with lipids is minimal, probably due to changes in conformation or state of association, or both, of the apoprotein; and (d) at lipid/apo-A-II ratios above 1, the formation of lipid-rich particles is due to a process characterized by an adsorption of apo-A-II to thermodynamically stable lipid vesicles followed by their disruption into particles heterogeneous in size and density. We conclude that the interaction of apo-A-II with HDL lipids is extremely sensitive to experimental conditions and that apo-A-II can be incorporated into lipoprotein particles of much broader distribution than those previously obtained in similar reassembly studies involving apolipoprotein A-I.

27777 Foerster transfer rates for chlorophyll a. Shipman, L.L.; Housman, D.L. (Argonne National Lab., IL). *Photochem. Photobiol.;* **29**: 1163-1167(9 Feb 1979).

A convenient formula has been derived for the calculation of Foerster transfer rates between chlorophyll a molecules. The formula is applicable over limited ranges of absorption maxima positions, Stokes' shifts, solvents, relative orientations and intermolecular distances. The limitations on the applicability of the Foerster transfer model are discussed. Finally, some implications for in vivo energy transfer are considered.

27778 Metabolism of α-ecdysone in intermolt land crabs (Gecarcinus lateralis). McCarthy, J.F.; Skinner, D.M. (Univ. of Tennessee, Oak Ridge). *Gen. Comp. Endocrinol.;* **37**: 250-263(1979).

The metabolic fate of γ-ecdysone was examined in intermolt crabs to elucidate the biochemical pathways as well as the dynamics of ecdysteroid metabolism. At 1 to 24 h after injection of α[^{3}H]ecdysone, metabolits were extracted from each of five tissues and separated by reverse-phase chromatography. Ecdysone metabolism proceeded through (i) sequential hydroxylation at C-20 and C-26, and (ii) formation of glycosidic conjugates of the free ecdysteroids. The conversion of α- to β-ecdysone (20-hydroxyecdysone) was very rapid; within 1 to 4 h, over 50% of the radioactivity was present as β-ecdysone. Further hydroxylation to 20,26-dihydroxyecdysone was less rapid, but continuous over the experimental period. Fractions of each of the three ecdysteroids were conjugated, probably as β-glycosides. These conjugates comprised 20% of the total radioactivity in the crab, over half of which was concentrated in the midgut gland and hindgut. Free and conjugated ecdysteroids, as well as an extremely polar material which was resistant to enzymatic hyrdrolysis, were excreted in both the urine and the feces. The rate of elimination of total radioactivity and the rate of turnover of β-ecdysone were fairly rapid but varied among the different tissues. The rate of turnover in the epidermis was very rapid ($k \sim 0.08\ h^{-1}$). Turnover in the caracass and the whole crab was slower ($k \sim 0.02\ hr^{-1}$), perhaps due to sequestration of some of the metabolites in tissues which are inactive in the metabolism of ecdysteroids.

27779 Nitrogen fixation in Clear Lake, California. 3. Repetitive synoptic sampling of the spring Aphanizomenon blooms. Horne, A.J. (Univ. of California, Berkeley); Sandusky, J.C.; Carmiggelt, C.J.W. *Limnol. Oceanogr.;* **24**: No. 2, 316-328(1979).

Nitrogen fixation (as acetylene reduction) and factors most likely to influence it were estimated simultaneously for 31 sites at eight stages of the 1971 and 1972 spring blooms of Aphanizomenon in naturally eutrophic Clear Lake. The major factor controlling rates of N_2 fixation was the number of Aphanizomenon heterocysts ($P < 0.001$). Environmental influences on fixation were largely mediated through heterocyst induction or repression. Regression analysis showed heterocysts highly negatively related to NO_3 ($P < 0.05$). At high (linear regressions) but not at low (log-transformed regressions) numbers, heterocysts were positively correlated with phosphate ($P < 0.05$). At low rates of N_2 fixation, heterocysts were also positively related to water clarity, chlorophyll (both $P < 0.05$), and temperature ($P < 0.01$). The role of very low levels of nitrate (2 to 22 $\mu g.liter^{-1}$ NO_3-N) in (apparently) indirectly suppressing heterocyst induction was unexpected. Only at high rates was N_2 fixation correlated with phosphate. Presumably at low rates sufficient phosphorus is available in this P-rich lake (14 to 43 $\mu g.liter^{-1}$ PO_4-P) to permit repression of heterocyst formation by low NO_3 levels. Ammonium suppressed N_2 fixation and heterocyst formation only where it was present in relatively large quantities (20 to 170 $\mu g.liter^{-1}$ NH_4-N). Early in the blooms, low rates of vegetative (i.e., nonheterocyst) N_2 fixation were indicated in the flake colonies of Aphanizomenon. These may have an anoxic center like that of Trichodesmium.

27780 Ionic strength-dependent conformational transitions of chromatin. Circular dichroism and thermal denaturation studies. Fulmer, A.W.; Fasman, G.D. (Brandeis Univ., Waltham, MA). *Biopolymers;* **18**: 2875-2891(1979).

High-molecular-weight chicken erythrocyte chromatin was prepared by mild digestion of nuclei with micrococcal nuclease. Samples of chromatin containing both core (H3, H4, and H2A, H2B) and lysine-rich (H1, H5) histone proteins (whole chromatin) or only core histone proteins (core chromatin) were examined by CD and thermal denaturation as a function of ionic strength between 0.75 and 7.0×10^{-3} M Na^+. CD studies as 21°C revealed a conformational transition over this range of ionic strengths in core chromatin, which indicated a partial unfolding of segment of the core particle DNA at the lowest ionic strength studied. This transition is prevented by the presence of the lysine-rich histones in whole chromatin. Thermal-denaturation profiles of both whole and core chromatins, recorded by hyperchromicity at 260 nm, reproducibly and systematically varied with the ionic strength of the medium. Both materials dis-

played three resolvable thermal transitions, which represented the total DNA hyperchromicity on denaturation. The fractions of the total DNA which melted in each of these transitions were extremely sensitive to ionic strength. These effects are considered to result from intra- and/or internucleosomal electrostatic repulsions in chromatin studied at very low ionic strengths. Comparison of the whole and core chromatin melting profiles indicated substantial stabilization of the core-particle DNA by binding sites between the H1/H5 histones and the 140-base-pair core particle.

27781 Analytical techniques for cell fractions. XXV. Concentration and two-dimensional electrophoretic analysis of human urinary proteins. Anderson, N.G.; Anderson, N.L.; Tollaksen, S.L.; Hahn, H.; Giere, F.; Edwards, J. (Argonne National Lab., IL). Contract W-31-109-ENG-38. *Anal. Biochem.;* **95**: 48-61(1979).

The diagnostic and experimental possibilities inherent in the analysis of human urinary proteins have not been realized largely because rapid and efficient concentration methods have not been available, and because the resolution of analytical methods used to study them was low. In addition, the view has been widely held that little new or useful information was to be obtained from the analysis of proteins in urine. In this paper, we examine two methods for concentrating urinary proteins sufficiently for analysis by high resolution two-dimensional (2-D) electrophoresis using the ISO-DALT system. In orienting studies by two of us (NLA and NGA), it was found that a large number of proteins are seen in 2-D gels of urine protein concentrates, and that unusual spots appeared in the urines of burn, muscular dystrophy, and some cancer patients. A minority of these have the spot locations of serum proteins, suggesting that many urinary proteins remain to be described. We therefore initiated a systematic series of studies directed toward the development of methods and systems that would be useful clinically for analyzing urinary proteins.

27782 Conformation of the neurotoxin crotoxin complex and its subunits. Hanley, M.R. (Univ. of California, Berkeley). *Biochemistry;* **18**: No. 9, 1681-1688(1979).

Crotoxin, the neurotoxin from Crotalus durissus terrificus venom, and its two subunits, crotoxin A and crotoxin B, have been examined by fluorescence and circular dichroism techniques. Model spectra of crotoxin, generated from the expected contributions of the individual subunits, agreed with experimental results only at pH 2, where crotoxin was fully dissociated. From pH 4 to 10, crotoxin spectra could not be simulated by subunit contributions. Comparison of the results at pH values favoring either association or dissociation indicated that complex formation was accompanied by (1) a 70% decrease in fluorescent emission intensity and a u-nm blue shift of the emission maximum, (2) an increase in the far-ultraviolet circular dichroism, and (3) a marked intensity enhancement of the near-ultraviolet circular dichroism spectrum. These observations were taken as evidence that tryptophan residues were masked by complex formation and that the crotoxin complex contained an increased proportion of ordered secondary structure, particularly β sheets. The results did not distinguish between conformational changes with subunit interaction or creation or ordered structure only at the subunit binding interface. Structural flexibility of the subunits was suggested from their ability to undergo reversible state changes by exposure to acid pH or guanidine hydrochloride. Examination of the concentration dependence of guanidine hydrochloride denaturation indicated that complex formation gave increased stability, although the subunits were individually quite resistant to guanidine hydrochloride denaturation. It is concluded that the ability of crotoxin and its subunits to exist in several reversible states is related to the control of the association-dissociation equilibrium of the complex and that conformational interconversion may be necessary for crotoxin to act on different target membranes.

27783 Alterations of enzyme levels in segmental aneuploids of Drosophila and maize. Birchler, J. (Univ. of Tennessee, Oak Ridge). *Genetics;* **91**: No. 4, S10(1979).

In maize, certain enzyme and protein levels have been found to be negatively correlated with several segmental aneuploids (1-2-3 doses), with the extreme limits being the inverse of the dosage relative to the diploid. In fewer cases, positive correlations with chromosome dosage are observed. The levels of alcohol and glutamate dehydrogenases and one protein species, all with structural genes in IL, are compensated in a dosage series and at least in the case of ADH, this appears to be due to a cancellation of an inverse effect by a gene dosage effect in scutellar tissue. In Drosophila, the X chromosome has been divided into thirteen single or combined trisomic regions using X;4 and X;Y translocations with the following enzymes being studied: G6PDH, 6PGDH, βHAD, αGPDH, IDH and ADH. Of the regions studied to date, multiple duplications in adult females specifically reduce one or more enzymes encoded by x or autosomal genes. The addition of the same duplications to males results in only slight or no alteration; therefore these effects do not themselves follow the rules of dosage compensation. Longer duplications in females have reductions of greater magnitude, but in some cases, the effect is less than the sum of the inclusive regions. Certain deficiencies in females produce specific elevations of X- encoded and one autosomally specified enzyme (ADH), while others reduce levels. Although there are numerous dosage sensitive regions altering the level of any one enzyme, Lucchesi and Rawls (1973) showed a positive correlation between enzyme level/cell and ploidy. The relationship of these observations to genetic balance phenomena found in higher eukaryotes will be discussed.

27784 Biomimetic approaches to artificial photosynthesis. Katz, J.J.; Wasielewski, M.R. (Argonne National Lab., IL). *Biotechnol. Bioeng. Symp.;* No. 8, 423-452(1978).

At this writing, solar heating and the direct conversion of sunlight to electricity are the most advanced technologies for solar energy conversion. It is a reasonable assumption that both of these techniques for solar energy conversion will achieve large scale use in the not too distant future. However, there are other less familiar and less widely discussed but in the long run perhaps more broadly useful approaches to solar energy conversion. One such approach, which is the subject of this paper, is the utilization of solar energy for chemical purposes rather than as a heat source or in competition with various nuclear technologies for the production of electricity. Green plants and certain bacteria, in fact, use solar energy in precisely this way. These organisms use the energy of sunlight to effect the synthesis of the great array of organic compounds (e.g., carbohydrates, proteins, lipids) charactistically produced by green plants. The process by which green plants use solar energy for chemical purposes is called photosynthesis, and it is one of the objects of this paper to survey some of the salient features of artificial photosynthesis as a general approach to solar green conversion.

27785 Electron microscopy of a DNA helix destabilizing protein crystal (gp32*I). Chiu, W.; Hosoda, J. (Univ. of California, Berkeley). pp 178-179 of Ninth international congress on electron microscopy. Vol. II. Toronto, Ontario; Microscopical Society of Canada (1978).

From 9. international congress on electron microscopy; Toronto, Ontario, Canada (1978).

Gp32 is a protein coded by gene 32 in bacteriophage T4. It is essential for DNA replication, recombination and repair. Gp32*I with molecular weight of 27,000 was obtained by proteolytic removal of 8000-dalton peptide from COOH-terminal of gp32 (Hosoda et al. to be published). It is a stronger helix destabilizer than gp32, and has been found to be able to replace gp32 in constructing an in vitro DNA replication apparatus, which is active in the leading strand synthesis. Thin gp32*I crystal was formed under a low salt condition in the absence of glycerol. A typical image of the crystal embedded in 1% glucose taken at low magnification is shown. The optical diffractogram in the insert confirms the crystallinity, though no visible feature is seen in the micrograph due to the low magnification power. By using the tungsten shadowing technique, the thickness of the crystal was measured, along with polystyrene latex spheres as a standard, to be between 85 to 400 A. A unique feature of gp32*I crystal is its relatively small thickness and a large flat two-dimensional area, which would make it a suitable specimen for high resolution structural studies.

27786 Membrane-bound iron-sulfur centers in photosynthetic systems. Malkin, R.; Bearden, A.J. (Univ. of California, Berkeley). *Biochim. Biophys. Acta;* **505**: 147-181(1978).

The application of electron paramagnetic resonance (EPR) spectroscopy to the study of iron-sulfur proteins was first made with mitochondria and submitochondrial particles and this was followed by characterization of soluble iron-sulfur proteins of the ferredoxin type as well as bound centers in photosynthetic systems. In the case of bacterial chromotophores and chloroplasts, the distinctive EPR properties of the iron-sulfur proteins made possible the detection of bound iron-sulfur centers in these systems, which were previously thought to contain only soluble ferredoxins. It is, however, more appropriate at the present time to denote these groups as iron-sulfur centers or clusters, rather than iron-sulfur proteins, since the association of these centers with specific proteins is not well established because extraction, purification, and characterization of iron-sulfur proteins from photosynthetic membranes has only been accomplished in a few instances. As in mitochondria, a multiplicity of iron-sulfur centers, firmly bound to membranes, has been found in chromotophores from photosynthetic bacteria as well as in chloroplasts and membrane fragments from other oxygen-evolving organisms, such as blue-green algae. In this review, we will consider the properties of these centers and their proposed roles in primary photochemical processes and secondary electron transfer reactions of photosynthetic organisms.

27787 RNA secondary structure: a complete mathematical analysis. Waterman, M.S.; Smith, T.F. (Univ. of California, Los Alamos). *Math. Biosci.;* **42**: 257-266(1978).

Using a rigorous mathematical analysis, the prediction of RNA secondary structure as a function of free energy is obtained. The iterative method effectively allows a search over the entire

configuration space of the RNA molecule not possible by earlier methods. The approach also allows for the direct inclusion of the nearest neighbor or stacking energies.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 27805, 27819, 27836, 27837, 27838, 27843, 27851, 27853

27788 (PNL—3300(Pt.1), pp 272-274) **Cell surface properties in rat C_6 glial cells and sublines.** Anderson, L.E.; Morris, J.E.; Winn, L.S.; Wiley, W.R. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

The relationship between density-dependent growth regulation and various cellular membrane properties was examined in a clonal glial cell culture, C_6, and two revertant sublines of C_6. Membrane proteins in both parental C_6 and in sublines show comparable electrophoretic patterns on polyacrylamide gels run in sodium dodecyl sulfate. Differences are seen in the ability of the cell types to bind the neutrotransmitter, norepinephrine: the two revertant sublines bind from 12% to 25% less norephinephrine when compared to parental C_6 cells. In other studies, an in vitro cytotoxicity assay was developed for evaluating cell-mediated immunity in rats, using C_6 and subline cells as labeled target cells.

27789 Glucocorticoid suppression of human lymphocyte DNA synthesis. Influence of phytohemagglutinin concentration. Segel, G.B.; Lukacher, A.; Gordon, B.R.; Lichtman, M.A. (Univ. of Rochester, NY). *J. Lab. Clin. Med.;* **95**: No. 4, 624-632(Apr 1980).

Glucocorticoids have been shown to suppress lectin-stimulated lymphocyte DNA synthesis in some studies, whereas in other studies, the hormones have had little effect. We have found that the position on the PHA dose-response curve that is studied is the most important determinant of whether cortisol inhibits ^{3}H-thymidine incorporation into lymphocyte DNA. The proportion of monocytes in culture also influenced the cortisol effect, but it was quantitatively less important than PHA concentration. Cortisol (5 nM to 100 μM) had little effect on blastogenesis or thymidine incorporation into DNA in cultures that contained both a high concentration (14% +- 2 (S.E.)) of monocytes and a concentration of PHA (0.6 to 1.2 μg/ml) that produced maximal stimulation of mitogenesis. When monocytes were reduced from 14 to 1.4%, cortisol (5 μM) caused a 30% reduction in thymidine incorporation in cultures stimulated by 0.6 to 1.2 μg/ml PHA. Much greater cortisol suppression of thymidine incorporation occurred if the concentration of PHA was reduced. For example, reduction of the PHA concentration from 1.2 to 0.075 μg/ml resulted in an increase in suppression by 5 μM cortisol from 5 to 90% even in the presence of 14% monocytes. These data indicate that the suppressive effects of glucocorticoids on blastogenesis and thymidine incorporation in vitro depend principally on the concentration of PHA used to stimulate blastogenesis and secondarily on the proportion of monocytes in the culture system.

27790 Camphorquinone-10-sulfonic acid and derivatives: convenient reagents for reversible modification of arginine residues. Pande, C.S.; Pelzig, M.; Glass, J.D. (Mount Sinai Medical and Graduate Schools, New York, NY). *Proc. Natl. Acad. Sci. U.S.A.;* **77**: No. 2, 895-899(Feb 1980).

Camphorquinone-10-sulfonic acid hydrate was prepared by the action of selenous acid on camphor-10-sulfonic acid. Camphorquinone-10-sulfonylnorleucine was prepared either from the sulfonic acid via the sulfonyl chloride or by selenous acid oxidation of camphor-10-sulfonylnorleucine. These reagents are useful for specific, reversible modification of the guanidino groups of arginine residues. Camphorquinonsulfonic acid is a crystalline water-soluble reagent that is especially suitable for use with small arginine-containing molecules, because the sulfonic acid group of the reagent is a convenient handle for analytical and preparative separation of products. Camphorquinonesulfonylnorleucine is more useful for work with large polypeptides and proteins, because hydrolysates of modified proteins may be analyzed for norleucine to determine the extent of arginine modification. The adducts of the camphorquinone derivatives with the guanidino group are stable to 0.5 M hydroxylamine solutions at pH 7, the recommended conditions for cleavage of the corresponding cyclohexanedione adducts. At pH 8-9 the adducts of the camphorquinone derivatives with the guanidino group are cleaved by o-phenylenediamine. The modification and regeneration of arginine, of the dipeptide arginylaspartic acid, of ribonuclease S-peptide, and of soybean trypsin inhibitor are presented as demonstrations of the use of the reagents.The use of camphorquinonesulfonyl chloride to prepare polymers containing arginine-specific ligands is discussed.

27791 Isolation and characterization of the three major low density lipoproteins from normolipidemic Rhesus monkeys (Macaca mulatta). Fless, G.M.; Scanu, A.M. (Univ. of Chicago, IL). Contract EY-76-C-02-0069. *J. Biol. Chem.;* **254**: No. 17, 8653-8661(10 Sep 1979).

The plasma of rhesus monkeys which were fed a normal chow diet was shown to contain several low density lipoproteins of which three major species, namely, LDL-I, LDL-II, and LDL-III were isolated by a combination of isopycnic and rate zonal density gradient ultracentrifugation. Of the 30 animals tested, 28 contained LDL-I and LDL-II, and 15 had, in addition to the first two components, LDL-III. Several exhibited additional minor LDL components. LDL-III with a mean buoyant density of 1.050 g/ml had an unexpectedly large molecular weight (3.47×10^6) when compared to LDL-I (3.32×10^6) and LDL-II (2.75×10^6) which had buoyant densities of 1.027 and 1.036 g/ml, respectively. The unusual physical properties of LDL-III were found to be due to a higher content and nature of its protein moiety, represented only by apo B according to electrophoretic criteria and radioimmunoassay. The protein of LDL-III (apo LDL-III) also differed from the other two in having a higher galactose and sialic acid content. Moreover, relative to LDL-I and LDL-II, LDL-III exhibited differences in behavior when using techniques of circular dichroism, radioimmunoassay, agarose- and sodium dodecyl sulfate-gel electrophoresis, which could be attributed to its protein moiety. In contrast, the molar lipid content of LDL-III was almost identical to that of LDL-I, and differential scanning calorimetry showed that the neutral lipids of the three LDLs undergo almost identicaltransitions below body temperature. When all of the data were analyzed according to the method of Shen et al., the major structural difference between LDL-III and the other two LDLs appeared to relate to the degree of occupancy and conformation of the apoprotein in the surface of the particles.

27792 Subunit interaction during catalysis: alternating site cooperativity in photophosphorylation shown by substrate modulation of [^{18}O]ATP species formation. Hackney, D.D.; Rosen, G.; Boyer, P.D. (Univ. of California, Los Angeles). Contract EY-76-S-03-0034. *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 8, 3646-3650(Aug 1979).

Pronounced substrate modulation of incorporation of water oxygen into ATP formed by photophosphorylation is observed, as measured by ^{31}P NMR analysis of products formed from ADP and highly ^{18}O-labeled P/sub i/. A marked increase occurs in oxygen exchange per ATP formed as ADP or P/sub i/ concentration is decreased. This is explainable by the binding-change mechanism for ATP synthesis, in which the energy linked release of ATP from one site requires the binding of ADP and P/sub i/ at an alternate site. Analysis of the distribution of ^{18}O-labeled species arising from the ATP formed eliminates explanations for substrate modulation based on preexisting or induced enzyme heterogeneity. Furthermore, the results, together with other related findings, make participation of control sites unlikely. The occurrence of alternating site catalysis cooperativity in ATP synthesis by chloroplasts thus appears to be reasonably well established.

27793 Reverse transcriptase pauses at N^2-methylguanine during in vitro transcription of Escherichia coli 16S ribosomal RNA. Youvan, D.C.; Hearst, J.E. (Univ. of California, Berkeley). *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 8, 3751-3754(Aug 1979).

A restriction fragment strand complementary to a sequence near the 3' end of Escherichia coli 16S rRNA has been used to prime reverse transcriptase (avian myeloblastosis virus RNA-directed DNA nucleotidyltransferase; deoxynucleosidetriphosphate:DNA deoxynucleotidyltransferase, EC 2.7.7.7). In addition to transcripts that were extended to the 5' end of the RNA, two major transcription intermediates were observed. These discrete-sized cDNA intermediates are the result of a kinetic barrier imposed by monomethylation of the amino group on guanine that participates in base-pairing. Both major transcription intermediates correspond to attenuation at the known positions of N^2-methylguanine (m^{2}G) in the rRNA sequence. The relaxation time for elongation of the cDNA through m^{2}G is approximately 3 min. No other major kinetic pauses were observed in the 1340 bases transcribed.

27794 Neoplastic responses and correlated plasma prolactin levels in diethylstilbestrol-treated ACI and Sprague-Dawley rats. Stone, J.P.; Holtsman, S.; Shellabarger, C.J. (Brookhaven National Lab., Upton, NY). *Cancer Res.;* **39**: 773-778(Mar 1979).

Pellets containing 5 mg [^{3}H] diethylstilbestrol (DES) and 15 mg cholesterol were implanted S.C. in 84-day-old female Sprague-Dawley (S-D) and ACI rats. DES was released from the implanted pellets exponentially, and the release was not significantly different in S-D rats than in ACI rats. No mammary tumors developed in any treated or untreated S-D rats. In contrast, 90% of the DES-treated ACI rats developed mammary adenocarcinomas. A significant increase in the weight of the pituitary was noted in DES-treated ACI rats. The pituitarities of the treated ACI rats were 2 to 7 times as heavy as were controls, and plasma prolactin levels were 10 to 40 times higher than in controls. In contrast, the pituitaries of treated S-D rats did not significantly increase in weight, and plasma prolactin levels were only 3 to 5 times higher than controls. The uteri of treated S-D rats were significantly heavier than those of control rats and contained large amounts of fluid. This effect was not seen in

ACI rats. Although the release of DES from the implanted pellet was essentially the same in ACI and S-D rats, three distinctive strain differences in response to DES were noted: mammary adenocarcinomas were found only in treated ACI rats; pituitary prolactin-cell adenomas and associated elevated plasma prolactins levels were seen only in treated ACI rats; and pyometritis was induced only in treated S-D rats. Mammary adenocarcinomas and prolactin-cell adenoma responses in the treated ACI rats appear to be correlated with the increasing levels of plasma prolactin. This study demonstrates that the prolonged estrogen treatment of ACI and S-D female rats produces distinctly different mammary and pituitary neoplastic responses. This disparity in neoplastic responses appears to be reflected in the difference of degree to which the hypophysical prolactin cells are stimulated to grow and secrete hormone.

27795 Accumulation and excretion of DDT by the terrestrial snail, Cepaea hortensis. Dindal, D.L.; Wurzinger, K.H. (State University Coll. of Forestry, Syracuse, NY). *Bull. Environ. Contam. Toxicol.;* **6**: No. 4, 362-371(1971).

Terrestrial gastropods (snails and slugs) have been shown to accumulate considerable quantities of the organochlorine insecticide DDT, with no noticeable toxic effect. These invertebrates serve as a source of this concentrated pesticide to vertebrate predators. Snails and slugs as non-target organisms accumulate DDT residues at concentrations equal to or considerably higher than the surrounding environment. Such information from the literature is summarized. Since little information is available on the site of residue accumulation in snails the present study was undertaken to determine the concentration and excretion of chlorine 36 DDT in the terrestrial pulmonate snail, Cepaea hortensis. Specific objectives of this study were as follows: (1) to determine the quantities of ^{36}Cl DDT that are accumulated and excreted by the snail Cepaea hortensis, after a single feeding of DDT; (2) to determine the tissue concentration of the radioactive DDT; and (3) to determine the dynamics of DDT in the snail tissues at intervals of three and twenty-four hours, two, four, and eight days.

CYTOLOGY

REFER ALSO TO CITATION(S) 27762, 27766, 27769, 27774, 27775, 27789, 27811, 27817, 27821, 27841, 27864, 27912, 27914, 27915, 27916, 27917, 27918, 27957, 27979

27796 Growth arrest of AKR-2B cells maintained in the presence of epidermal growth factor or 12-O-tetradecanoylphorbol-13 acetate: evidence for two separate G_1 arrest points. Moses, H.L.; Proper, J.A.; Volkenant, M.E.; Swartzendruber, D.E. (Los Alamos Scientific Lab., NM). *J. Cell. Physiol.;* **102**: No. 3, 367-378(Mar 1980).

Nontransformed mouse embryo derived AKR-2B cells stop growing in the G_1 phase of the cell cycle at saturation density due to depletion of serum growth factors, whereas a chemically transformed derivative line (AKR-MCA) arrests growth in G_1 at a higher saturation density due to depletion of amino acids and glucose. Stimulation of DNA synthesis is inhibited in the AKR-2B cells, but not in the AKR-MCA cells, by two inhibitors of RNA metabolism, α-amanitin and 5-fluorouridine (5-FU). To determine whether the AKR-MCA cells growth arrest at a unique point in G_1 or whether they arrest in a physiologic state which can also be achieved by the nontransformed cells, AKR-2B cells were maintained in medium with 10% serum containing the mitogens, epidermal growth factor (EGF) or 12-0-tetradecanoylphorbol-13-acetate (TPA), until they reached saturation density or were arrested at subconfluence by artificial deletion of amino acids from the medium. The AKR-2B cells maintained in EGF or TPA stopped growing in G_1 at a higher saturation density, due to depletion of amino acids. Cells arrested in EGF or TPA or in amino acid deficient medium had a shortened interval between stimulation and the onset of DNA synthesis, and the stimulation of DNA synthesis was not inhibited by α-amanitin of 5-FU. The data show that the nontransformed AKR-2B cells have two different arrest states which may represent two separate and distinct G_1 arrest points-a growth factor deficiency arrest point and a nutrient deficiency arrest point. The nutrient deficiency arrested cells were very similar to the G_1 arrested transformed AKR-MCA cells.

27797 In vivo function of immune murine peritoneal exudate cells after freezing and thawing. Adkison, L.R.; Coggin, J.H. Jr. (Univ. of South Alabama, Mobile). Contract EE-77S-055601. *Proc. Soc. Exp. Biol. Med.;* **163**: No. 1, 60-63(Jan 1980).

Peritoneal exudate cells were collected from Balb/c mice immunized against a 3-methylcholanthrene-induced (3-MCA) tumor and known to be capable of conferring tumor transplantation resistance in vivo in syngeneic recipients. These PEC were frozen-using dimethylsulfoxide as the cryopreservative agent. Adoptive transfer of tumor resistance in syngeneic recipients challenged with homologous 3-MCA sarcoma cells was attempted using these frozen exudate cells. Cells were thawed 1, 4, 7, 10 or 30 days after freezing and admixed with tumor cells in ratios of 100:1 or 1000:1 before injecting into mice. Tumorigenesis was decreased and delayed in groups receiving the 100:1 ratio. Less than 3% of the mice developed tumors in groups receiving the 1000:1 ratio. The number of cells recovered post-thawing ranged from 60 to 80%; viability of post-thawed cells ranged from 80 to 96%.

27798 Inhibition of human lymphocyte E-rosette formation by oxygenated sterols. Streuli, R.A.; Chung, J.; Scanu, A.M.; Yachnin, S. (Franklin McLean Memorial Research Inst., Chicago, IL). Contract EY-76-C-02-0069. *J. Immunol.;* **123**: No. 6, 2897-2902(Dec 1979).

25-Hydroxycholesterol, 20α-hydroxycholesterol, 7α-hydroxycholesterol, and 5α-hydroxy-6-ketocholestanol, when added to cultures of human lymphocytes in lipoprotein-depleted medium (LPDM) at a concentration of 2.5×10^{-5} M, inhibit E-rosette formation with sheep red blood cells. 20α-Hydroxycholesterol, 7α-hydroxycholesterol, and 5α-hydroxy-6-ketocholestanol are more potent inhibitors than 25-hydroxycholesterol. The inhibitory effect of 5α-hydroxy-6-ketocholestanol on E-rosette formation appears after 15 min of exposure; with the other three compounds, an exposure time of 18 h is necessary. The inhibitory effect on E-rosette formation can be abolished by addition of free cholesterol, low-density lipoprotein, or high-density lipoprotein to the LPDM or by incubation of the cells in normal AB serum, but not by the addition of mevalonic acid to the LPDM. These observations suggest that the capacity of oxygenated sterol compounds (OSC) to inhibit E-rosette formation is independent of their inhibitory effect on sterol synthesis. It is possible that OSC inhibit E-rosette formation as a consequence of their insertion into the lymphocyte membrane as cholesterol analogues.

27799 In vivo cooperation of murine lymphocytes sharing one haplotype of the transplantation genes: a requirement for tolerance of the nonshared haplotype. Marusic, M.; Perkins, E.H. (Oak Ridge National Lab., TN). *J. Immunol.;* **122**: No. 3, 1116-1120(Mar 1979).

The ability of mouse thymus-dependent (T) and bone marrow-derived (B) lymphocytes to cooperate in the (humoral) rejection of the rat Yoshida ascites sarcoma (YAS) was investigated. Mice of two hybrid constitutions that had one parent of the same strain and the other of a different strain were used. T and B cells thus shared one haplotype of the transplantation genes, but the other haplotype was different so that allogeneic recognition could take place in both directions. To investigate the influence of allogeneic recognition on T-B cell cooperation mice were also made mutually tolerant by establishing long-term radiation chimeras. Erythrocytes and spleen cells of the chimera were shown by serologic analysis to be donor-type. When the chimera was to serve as tumor host and B cell source, it was thymectomized before irradiation and reconstitution with Thy 1.2 antisera and complement-treated bone marrow (TIR). The evidence of tolerance was markedly reduced antihost-type reactivity in short-term in vivo [^{3}H]thymidine uptake studies. Successful cooperation, manifested by YAS rejection in TIR mice given splenic T cells, was seen (a) whenever the transferred T cells and the cells of the TIR recipient were syngeneic, and (b) when the T cells were nonsyngeneic with the cells in TIR recipients but were obtained from chimeric donors and injected into chimeric recipients. Chimerism of only T cell donors or TIR recipients was not sufficient for YAS rejection to be induced.The data suggest that the allogeneic recognition on either T or B lymphocytes may thwart otherwise successful cell cooperation.

27800 Nuclear retention of 18S ribosoma RNA by human myeloma cells. Bynum, J.W. (Southern Illinois Univ., Carbondale); Volkin, E. *Cell Tissue Res.;* **197**: 347-351(1979).

Normal quiescent lymphocytes regulate their ribosome content by selectively degrading newly synthesized 18S ribosomal RNA. Unlike actively dividing HeLa cells, lymphocytes retain 18S ribosomal RNA in the nucleus after synthesis instead of immediately transporting it to the cytoplasm. Subcellular fractionation of the highly differentiated human neoplastic lymphocyte RPMI-8226 reveals that this cell line also retains 18S ribosomal RNA in the nucleus, a trait not displayed by the less differentiated human lymphoblastoid cell line RPMI-4265. These observations suggest that neoplastic cells can be phenotypically characterized by their ribosomal RNA processing patterns.

27801 Turnover of endogeneous microinjected and sequestered protein in xenopus oocytes. Wallace, R.A. (Oak Ridge National Lab., TN); Hollinger, T.G. *Exp. Cell Res.;* **119**: 277-287(1979).

Pulse-labeled oocyte proteins were found to be a maximum average half-life of 73 h. In general, larger peptides underwent degradation at a faster rate than smaller peptides. In this respect, oocytes are similar to most other cells. Microinjected ^{125}I-labeled bovine serum albumin (BSA) was degraded over a 40 h period with a half-life of 20 to 30 h, regardless of the method of protein labeling, culture medium employed, size of oocyte microinjected, or hormonal history of the oocyte. The last two results, if applicable to oocyte

proteins in general, imply that protein catabolism is constant throughout the later stages of oogenesis and that growth is primarily regulated by a stimulation of anabolism. Individual proteins microinjected into oocytes undergo rates of degradation consistent with turnover rates obtained in other systems. Sequestered ^{125}I-labeled BSA is only partially (40%) degraded, which indicates that, unlike microinjected ^{125}I-labeled BSA, it has access to a cytoplasmic compartment (yolk platelets?) within which it is relatively stable.

27802 Preparation and observation by SEM of hemopoietic cells cloned in soft agar. Seed, T.M.; Chubb, G.T.; Ulrich, R.G.; Wright, B.J.; Kaspar, L.V. (Argonne National Lab., IL). pp 397-410 of Scanning electron microscopy. O'Hare, IL; SEM Inc. (1979).

A method is described to prepare clones of hemopoietic cells grown in soft agar for scanning electron microscopy (SEM). A critical modification of the otherwise quite standard SEM processing procedure for biological samples involved the use of silver micropore disks as an adherent substrate to support the highly labile, deformable agar slabs. This support allows maintenance of the normal flat pancake shape of the specimen through the thiocarbohydrazide osmium ligand binding steps, dehydration, and critical point drying. With this support and careful dissection of the surface agar with a fine steel needle using a stereomicroscope, selected areas and depths within the colony can be exposed and examined by SEM. Surface topography of cloned cells can be correlated with intracellular cytological features by excising areas of interest and directly embedding them in plastic for thinsection preparation and viewing by transmission electron microscopy (TEM). The dried-specimen-teasing method appears useful, because of the ease of preparation of the specimens, its reproducibility, and the degree of visibility and preservation of cell surface structures and intraclonal relationships. Our initial observations, using combined EM techniques, indicate that clonal cell topography is highly variable and that this variability appears to be related both to the relative age and proliferative status of the colony. Based on work to date, we suggest that topographical and spatial analysis, in vitro, of cloned, agar-embedded hemopoietic stem cells is possible with simple modifications of conventional SEM preparative techniques.

27803 Age-associated changes in T-B cell cooperation demonstrated by the allogeneic effect. Popp, D.M.; Francis, M. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Mech. Ageing Dev.;* **10**: 341-353(1979).

The allogeneic effect results in an increase in the number of antibody-producing cells (PFC) when the allogeneically stimulated lymphoid cells and the antibody-producing cells are from young individuals. This increase depends on the interaction of allogeneically stimulated T-cells and precursor plasma cells (B-cells). Age-associated deficiencies in these two cell populations were studied in these experiments by use of allogeneically stimulated T-cells from old donors or responding B-cells from old recipients. These experiments showed that lymphocytes from 20-month-old mice were capable of inducing an increase in PFC in young recipients. However, the allogeneic effect was ineffectual in 12-month-old mice. These data suggest that the T-helper function is equally capable in mice 4 to 20 months old, but that the B-cell is not as effectively recruited. The possible causes for limited B-cell recruitment are discussed.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 27788, 27853

27804 (PNL—3300(Pt.1), pp 220-223) **Culture conditions affecting the incorporation of ^{125}I-labelled iododeoxyuridine into DNA of mitogen-stimulated canine lymphocytes.** Morris, J.E.; Graham, T. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

A series of experiments have been conducted to define and describe the response of canine lymphocytes in the mitogen stimulation assay systems. These studies include the effects of serum, mitogen, and FUDR concentrations on the incorporation of ^{125}I-IUDR by canine lymphocytes.

27805 Changes in thymine pool equilibration times during the S phase of mammalian cells. Mattern, M.R.; Kapp, L.N. (Univ. of California, San Francisco). *Exp. Cell Res.;* **120**: 95-100(1979).

The thymine precursor pool equilibration times for DNA labelled with [^{3}H]thymidine during various parts of S were determined for Chinese hamster ovary (CHO) cells and for the human cell lines HeLa S3 (aneuploid) and E-11 fibroblasts (diploid). Pool equilibration times reached maximum and minimum values at characteristic parts of S in CHO nd E-11 cells, as determined by plotting the specific activity of nascent DNA as a function of pulse-labelling times. Renaturation kinetics of nascent DNA in CHO cells had indicated previously that a class of moderately repeated nucleotide sequences had a shorter thymine pool equilibration time than other sequences, leading to their overproduction during labelling of cells with thymidine for times shorter than the pool equilibration time. In the present experiments, the replication of these sequences occurred during those parts of S in which the thymine pool equilibration times for total nascent DNA labelling were shortest. In HeLa cells, the variation in pool equilibration time was less than in CHO and E-11 cells, and renaturation kinetics revealed no overproduction of moderately repeated nucleotide sequences at any time during S. Thus, one kind of order may characterize DNA replication in CHO cells and diploid human fibroblasts but not in HeLa cells.

GENETICS

REFER ALSO TO CITATION(S) 27758, 27768, 27780, 27783, 27785, 27799, 27824, 27826, 27835, 27837, 27839, 27856, 27925, 27927, 27959, 27976, 27978, 27979, 27980

27806 (DOE/EV/71005—52) **Continuous-genotype models and asortative mating: is wright wrong.** Felsenstein, J. (Washington Univ., Seattle (USA)). 1979. Contract AT06-76EV71005. 23p. (RLO—2225-5-52). NTIS, PC A02/MF A01.

The report addresses the question of whether the classical theory of asortative mating due to Fisher (1918) and Wright (1921) involves arbitrary and unjustified assumptions. (ACR)

27807 (UR—3490-1859) **Transformation of Bacillus Subtilis with cloned thymidylate synthetases.** Rubin, E.M. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1980. Contract AC02-76EV03490. 112p. NTIS, PC A06/MF A01.

Thesis.

Bacillus subtilis carries two genes, thyA and thyB, each encoding different protein products, with thymidylate synthetase (TSase) activity. Either of these genes alone is sufficient for thymidine independence in B. subtilis. In addition there exist two B. subtilis temperate bacteriophages which upon infection of thymine requiring auxotrophs results in conversion of the organism to thymine independence. Chimeric plasmids selected for Thy$^+$ transforming activity in E. coli were constructed and then used as a source of defined highly enriched DNA with which to transform competent B. subtilis. These plasmids were studied for their: (1) abiility to transform B. subtilis to thymine independence; (2) site of integration within the B. subtilis chromosome upon transformation; (3) phenotype of Thy$^+$ plasmid generated transformants; and (4) nucleotide sequence homology among the cloned DNA fragments conferring thymine independence. Plasmids containing the two bacteriophage thy genes displayed the phenotype associated with thyA, whereas the plasmids containing the cloned B. subtilis chromosomal genes displayed the phenotype associated with thyB. Utilizing similar technology, the ability of an entirely foreign hybred bacterial plasmiid to transform B. subtilis was examined. In this case the gene from E. coli encoding thymidylate synthetase was cloned in the plasmid pBR322. The resulting chimeric plasmid was effective in transforming both E. coli and B. subtilis to thymine prototrophy. Uncloned linear E. coli chromosomal DNA was unable to transform thymine requiring strains of B. subtilis to thymine independence. Although the Thy$^+$ transformants of E. coli contained plasmid DNA, the Thy$^+$ transformants derived from the transformation of B. subtilis did not contain detectable extrachromosomal DNA. Instead the DNA from the chimeric plasmid was integrated into the chromosome of B. subtilis. (ERB)

27808 r- and K-selection in a completely chaotic population model. Felsenstein, J. (Univ. of Washington, Seattle). Contract AT(45-1)2225. *Am. Nat.;* **113**: No. 4, 499-510(Apr 1979).

A model of discrete-generations population dynamics originally due to M.H. Williamson is analyzed. In this model, the negative effect of population density acts suddenly and completely as the population size passes a threshold. The model almost always yields chaotic fluctuation of population size. When it does, this chaos ensues whatever the initial population size. The average population cycle length is found, as well as the distribution of population sizes over time. One can readily analyze r- and K-selection in this model. Natural selection will favor cycles with more time spent above the threshold population size, and will favor increase of the threshold. When r- and K-selection oppose each other, protected polymorphism is possible in an asexual or halploid population, but only if the genotype which would be lost if there were no K-selection has the greater fluctuation when present alone. Conditions for protected polymorphism in a two-allele diploid population are also given.

27809 Developmental changes of sepiapterin synthase activity associated with a variegated purple gene in Drosophila melanogaster. Tobler, J.E.; Yim, J.J.; Grell, E.H.; Jacobson, K.B. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Biochem. Genet.;* **17**: No. 1/2, 197-206(1979).

A variegated position effect on the autonomous gene, purple, has been studied enzymologically in Drosophila melanogaster. Se-

piapterin synthase, the enzyme system associated with pr^+, was examined for activity in different developmental stages of the fly. The results indicate that T(Y:2)pr/sup c5/, cn/pr/sup c4/ cn flies (flies in which pr^+ has been translocated and which exhibit variegation) have a reduced amount of enzyme activity as compared with both Oregon-R and pr^1 flies. This reduction in activity was not found in larval stages, which suggests that the inactivation process probably occurs in late larval or early pupal stages. The phenotype of the variegated adult has white eyes with red-colored spots and patches where drosopterins occur. The phenotype of the fly carrying the translocation is modified by the presence of additional Y chromosomes. This extends the observation from other systems that extra heterochromatin acts to suppress the variegated position effect. The advantages of studying the variegation by measuring enzyme activity, as well as the phenotypic expression, are several; for example, the developmental time at which variegation occurs may be estimated even though drosopterin synthesis is not occurring.

27810 Defective interfering particles of poliovirus: mapping of the deletion and evidence that the deletions in the genomes of DI(1), (2), and (3) are located in the same region. Nomoto, A. (State Univ. of New York, Stony Brook); Jacobson, A.; Lee, Y.F.; Dunn, J.; Wimmer, E. *J. Mol. Biol.;* **128**: 179-196(1979).

The deletions in RNAs of three defective interfering (DI) particles of poliovirus type 1 have been located and their approximate extent determined by three methods. (1) Digestion with RNase III of DI RNAs yields the same 3'-terminal fragments as digestion wth RNase III of standard virus RNA. The longest 3'-terminal located in the 5'-terminal half of the polio genome. (2) Fingerprints of RNase T_1-resistant oligonucleotides of all three DI RNAs are identical and lack four large oligonucleotides as compared to the fingerprints of standard virus, an observation suggesting that the deletions in all three DI RNAs are located in the same reregion of the viral genome. The deletion-specific oligonucleotides have also been shown to be within the 5'-terminal half of the viral genome by alkali fragmentation of the RNA and fingerprinting poly(A)-linked (3'-terminal) fragments of decreasing size. (3) Virion RNA of DI(2) particles was annealed with denatured double-stranded RNA (RF) of standard virus and the hybrid heteroduplex molcules examined in the electron microscope. A single loop, approximately 900 nucleotides long and 20% from one end of the molecules, was observed. Both the size and extent of individual deletions is somewhat variable in different hetereoduplex molecules, an observation suggesting heterogeneity in the size of the deletion in RNA of the DI(2) population. Our data show that the DI RNAs of poliovirus contain an internal deletion in that region of the viral genome known to specify the capsid polypeptides. This result provides an explanation as to why poliovirus DI particles are unable to synthesize viral coat proteins.

27811 DNA measurements of mitotic chromosomes of the rabbit (Orytolagus cuniculus). Ashworth, L.K.; Carrano, A.V.; Mayall, B.H. (Univ. of California, Livermore). Contract W-7405-ENG-48. *Cytogenet. Cell Genet.;* **24**: 68-71(1979).

DNA cytophotometry was used to obtain the relative DNA content of mitotic chromosomes of Orytolagus cuniculus. DNA ranking of the rabbit chromosomes is presented and related to the quinacrine and Giemsa-banded karyotpe. In addition, the relative DNA content of the short and long arms of each chromosome was calculated and the DNA-based centromeric index (i.e., the ratio of long-arm DNA to total chromosomal DNA) determined. The Y chromosome is clearly a submetacentric chromosome on the basis of the DNA measurements.

27812 Evidence for maternal effect in the regulation of basal levels of immunoglobulin A in mice. Popp, D.M. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Genetics;* **91**: No. 4, S98(1979).

A congenic pair of mice, C57BL/10 and C57BL/10.F, have been shown to have different basal serum levels of IgA. The serum IgA level of B10 is 254 +- 33 mg/dl and B10.F is 67 +- 8 mg/dl. Unexpectedly, reciprocal F_1 hybrids between these strains also have different basal serum levels. The (B10 x B10.F)F_1 has a basal serum IgA level of 353 +- 33 mg/dl and (B10.F x B10)F_1 has a basal serum level of 92 +- 10 mg/dl. Thus, the F_1 hybrids of the high maternal parent have high circulating levels of IgA and the F_1 hybrids of the low maternal parent have low circulating levels. The low phenotype segregates in F_2 and backcross populations. Since these mice are congenic at the major histocompatibility complex, H-2, the progeny were also tested for their H-2 haplotype. The segregation ratios suggest that at least 2 genes control the immunoglobin levels. One of the genes is linked to H-2. The maternal parent of the F_1 hybrid influences the expression of the serum IgA levels among the backcross and F_2 progeny, but the data show that the maternal effect is not due to a sex-linked recessive gene. The basis of the maternal effect is under investigation.

27813 Murine alpha thalassemia: effects on development and hemoglobin synthesis. Popp, R.A.; Bradshaw, B.S.; Skow, L.C. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Genetics;* **91**: No. 4, S98(1979).

Human alpha thalassemia is a congential disease causing a deficiency in the synthesis of alpha chains of hemoglobin. Homozygous individuals (hydrops fetalis) usually die during late pregnancy. Alpha thalassemia in mice has been induced by X-irradiation of males. Clinical symptoms in heterozygous mice are similar to those in man, e.g. microcytosis, reticulocytosis, poikilocytosis and hypochromia. Genetic studies showed that all viable alpha thalassemic progeny of matings of alpha thalassemic females and males were heterozygotes. Examination of preimplantation blastocysts flushed from the uterus of alpha thalassemic females at 86 hours after mating with alpha thalassemic males showed that about three-fourths of the embryos were composed of more than 32 blastomeres and had reached the early blastocyst stage while the remaining one-fourth of the embryos were composed of 32 or less blastomeres and were still at the morula stage of development. About one-fourth of the implantation sites did not contain live fetuses at 11 to 15 days of development. Histological examination at 5 to 8 days of gestation showed that the homozygous alpha thalassemic embryos implanted and developed to the late blastocyst stage when they became necrotic. At 11 to 15 days of development, the primitive nucleated erythrocytes appeared to be normal. However, the anucleated erythrocytes, which differentiate in the fetal liver, of alpha thalassemic fetuses contained abnormal eosinophilic inclusions that may be aggregations of beta chain polypeptides. The electrophoretic pattern of hemoglobins from alpha thalassemic fetuses and adults are distinguishable from those of their normal littermates. The differences can be explained on the basis of deficient alpha chain synthesis and the different affinities of the various kinds of alpha and non-alpha chains during the assembly of polypeptides of the tetrameric hemoglobin molecule.

27814 Use of chimeras in studying sterility of X-autosome translocation male mice. Russell, L.B.; Larsen, M.M.; Cacheiro, N.L.A. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Genetics;* **91**: No. 4, S108-S109(1979).

In at least 14 translocations that involve the X chromosome and one of 7 different autosomes of the mouse, heterozygous males are totally sterile. In order to help elucidate the cause of sterility, we have made aggregation chimeras between translocation and normal males. Since it is known that male phenotypes can result also from female-male chimeras, sex-linked markers as well as autosomal color markers were included to the crosses, in the hope of being able to identify the male-male type having a translocation component. While 24 were phenotypically chimeric with all 8 possible combinations represented. Cytological analysis of many of these 24 verified the diagnosis made on the basis of phenotype. Breeding tests of 74 males derived from aggregated morulae yielded 10 steriles, including 4 that were aggregates of a translocation male and nontranslocation female. However, the only two male-male chimeras with a translocation component were fertile, breeding from the normal component only. This indicates that the sterility of T(X;A) males is not due to organismic causes, such as might come about as a result of position effects. In keeping with this conclusion is the finding that in all 11 T(X;A) stocks studied at Oak Ridge, a spermatogenic block occurs at (or near) pachytene in hetrozygous males.

27815 Problems of assessing the genetic impact of mutagens on man. Newcombe, H.B. (Atomic Energy of Canada Ltd., Chalk River, Ontario). *Can. J. Genet. Cytol.;* **20**: No. 4, 459-470(Dec 1978).

Available human data, of the kinds needed to assess the genetic harm to man from possible changes in his mutation rate, currently suffer from major limitations. In particular there is uncertainty about (a) the total amount of hereditary disease, (b) the fraction of this that is mutation-related and therefore likely to be increased in frequency as a result of exposures to elevated levels of environmental mutagens, and (c) the severities of the mutation-related conditions and the collective public health importance of any anticipated increases in their frequencies. Standards of protection against environment mutagens cannot be set on the basis of laboratory data alone, and more effort on the part of geneticists will need to be directed towards quantitative assessment of the impact of the mutagens in terms of human disease. The needs for relevant human data, and various deficiencies in the statistical informaion that is currently available, are discussed.

METABOLISM

REFER ALSO TO CITATION(S) 27757, 27778, 27779, 27801, 27827, 27846, 27932, 27942

27816 Assessment of total catalytic sites and the nature of bound nucleotide participation in photophosphorylation. Rosen, G.; Gresser, M.; Vinkler, C.; Boyer, P.D. (Univ. of California, Los Angeles).

Contract EY-76-S-03-0034. *J. Biol. Chem.;* **254**: No. 21, 10654-10661(10 Nov 1979).

Application of new hexokinase accessibility method for the measurement of bound [^{32}P]ATP during steady state photophosphorylation by chloroplast thylakoids, together with mixing-quenching and filtration techniques has shown the following. (1) Two classes of bound ATP exist: a transitorily tightly bound class that represents a catalytic intermediate and a noncatalytic class of tightly bound ATP that is labeled much more slowly, presumably from medium components. Thylakoids filtered after a few seconds of photophosphorylation have some of both classes present. Thus, ATP may remain bound at a catalytic site on membranes in the absence of continued energization. (2) During steady state photophosphorylation, the sum of catalytically competent bound ATP plus P/sub i/ is considerably greater than 1/chloroplast ATP synthase complex even when substrate concentration limits the synthesis rate. At a given instant, therefore, most or all phosphorylation complexes are functional, with the simultaneous participation of more than one catalytic site/enzyme. (3) During photophosphorlyation, with substrate concentration well below K/sub m/ values, most ATP synthase complexes retain a bound, catalytic ATP. This behavior is not consistent with independent catalytic sites. These results give additional support to the view developed in this laboratory that ATP synthesis is accomplished by a mechanism in which two catalytic sites are functioning alternately on the ATP synthase. This mechanism proposes that energy-linked conformational changes in the ATP synthase promote binding of P/sub i/ and ADP in mode competent for ATP synthesis at one catalytic site and concomitantly the release of tightly bound ATP from an alternate site.

27817 Stimulation of CO_2 incorporation and glutamine synthesis by 2,4-D in photosynthesizing leaf-free mesophyll cells. Paul, J.S.; Krohne, S.D.; Bassham, J.A. (Univ. of California, Berkeley). *Plant Sci. Lett.;* **15**: 17-24(1979).

Addition of 2,4-D to mesophyll cells isolated from leaves of Papaver somniferum resulted in a significant increase in photosynthetic CO_2 incorporation as well as a stimulation of glutamine synthesis. Evidence is presented that the rise in glutamine is due to increased reduction of nitrate to ammonia.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 27795, 27928, 27933, 27934

27818 (BNL—27845) **Functional imaging of the brain with ^{18}F-fluorodeoxyglucose.** Reivich, M.; Greenberg, J.; Alavi, A.; Hand, P.; Rintelmann, W.; Rosenquist, A.; Christman, D.; Fowler, J.; MacGregor, R.; Wolf, A. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 13p. (CONF-800388—1). NTIS, PC A02/MF A01.

From 12. research conference on cerebral vascular disease; Williamsburg, VA, USA (2 Mar 1980).

A techniques is reported by which it is possible to determine which regions of the human brain become functionally active in response to a specific stimulus. The method utilizes ^{18}F-2-fluoro-2-deoxyglucose ([^{18}F]-FDG) administered as a bolus. [^{18}F]-FDG is used as a tracer for the exchange of glucose between plasma and brain and its phosphorylation. The subject is then scanned during administration of a physiologic stimulus by position emission tomography and the three-dimensional distribution of ^{18}F activity in the brain determined. (ACR)

27819 Reduced chromium retention in patients with hemochromatosis, a possible basis of hemochromatotic diabetes. Sargent, T. III; Lim, T.H.; Jenson, R.L. (California Univ., Berkeley). *Metabolism;* **28**: No. 1, 70-79(Jan 1979).

Chromium (III) has recently been shown to be an essential trace mineral in rats, being required for normal function of insulin in controlling glucose metabolism. Chromium is transported in the body bound to transferrin, where it binds competitively with iron. Hemochromatosis is an iron storage disease in humans characterized by highly saturated transferrin levels and sometimes by diabetes. We postulated that the diabetes may be due to exclusion of chromium by iron at metabolic binding sites. ^{51}Cr(III) was administered i.v. to 5 normal males, 6 patients with hemochromatosis prior to therapeutic removal of iron, and 5 patients with varying levels of iron loading. The retention of ^{51}Cr was measured with a whole-body counter for 8 mo and blood levels were measured for 40 to 80 days. Analysis of the whole-body retention curves revealed 3 exponential components with T/sub 1/2/s of .56 days, 12.7 days, and 192 days; the blood curves had 4 components with T/sub 1/2/s of 13 min; 6.3 hr, 1.9 days, and 8.3 days. The T/sub 1/2/s were not significantly different between the normals and patients. The coefficients of these components however, were significantly lower for the long T/sub 1/2/ components in the iron-loaded patients, demonstrating reduced retention of ^{51}Cr as postulated. Whether this reduced retention of chromium is causally relatd to diabetes in hemochromatosis and whether abnormal chromium metabolism is involved in endogenous diabetes, thus, becomes an important question for future study.

MEDICINE

REFER ALSO TO CITATION(S) 27775, 27781, 27800, 27842, 27852, 27909, 27953

27820 Cardiopulmonary function and morphologic changes in beagle dogs after multiple lung lavages. Muggenburg, B.A.; Mauderly, J.L.; Halliwell, W.H.; Slauson, D.O. (Inhalation Toxicology Research Inst., Albuquerque, NM). Contract EY-76-C-04-1013. *Arch. Environ. Health;* **35**: No. 2, 85-91(Mar 1980).

This study evaluated the long-term biomedical risks of multiple, massive saline lung lavage using dogs. Risks were assessed using clinical examinations of cardiopulmonary function, thoracic radiographs, auscultation of the chest, body temperature, and hematologic values. Thirty-six dogs given 10 lavages over a 49-day period had no gross lesions at time of necropsy 7 days after the last lavage. Six dogs, followed with clinical examinations after each of 10 lung lavages, had no detectable effects from the lavage except for elevated body temperature and bronchial breathing at 24 hr after some procedures. No gross lesions were found at sacrifice 28 days after the last lavage. The only histologic lesions found were those also found in unlavaged control dogs. Six dogs that were lavaged 10 or more times had normal pulmonary function values for 4 yr after the last lung lavage. No chronic sequelae were found in healthy beagle dogs given 10 or more lung lavages suggesting a minimal long-term risk associated with these procedures.

27821 Lymphoreticular fragments, the cellular debris of acute lymphosarcoma cell leukemia. Conjalka, M.; Rajdev, N.; Tavassoli, M. Contract EP-78-S-0899. *Cancer;* **44**: No. 6, 2124-2126(Dec 1979).

Lymphosarcoma cell leukemia cells have a propensity to fragment. In the following case, these fragments were initially interpreted by an electronic cell counter as platelets, thereby obscuring a true thrombocytopenic situation. These fragments may also resemble polychromatophilic red cells thus giving rise to the erroneous impression that a hemolytic process is accompanying this B cell leukemia.

27822 Improved gas chromatographic quantitation of breath hydrogen by normalization to respiratory carbon dioxide. Niu, H.C.; Schoeller, D.A.; Klein, P.D. (Univ. of Chicago, IL). *J. Lab. Clin. Med.;* **94**: No. 5, 755-763(Nov 1979).

A gas-solid chromatographic system using tandem silica gel and molecular sieve columns is described for the measurement of hydrogen, carbon dioxide, oxygen, and nitrogen in samples of respiratory gases. This system has a detection limit of 2 ppM of hydrogen in a 1 ml sample and can measure 120 ppM H_2 and 5% CO_2 with relative standard deviations of 1.3 and 1.7%, respectively. Improved sample storage and withdrawal techniques are described that give reproducible values for up to 6 weeks after collection. Finally we show that normalization of breath hydrogen values to an alveolar concentration, using the observed carbon dioxide concentrations, substantially reduces the range and variance of apparent H_2 concentrations in human subjects. Normalization eliminates the need for rebreathing or end-expiratory collection techniques and substantially increases the reliability and clinical utility of hydrogen breath measurements in noninvasive tests of carbohydrate malabsorption.

27823 Steroid synthesis: the modified Hunsdiecker degradation of bile acids and related compounds. Knapp, F.F. Jr. (Oak Ridge National Lab., TN). *Steroids;* **33**: No. 3, 245-249(Mar 1979).

The modified Hunsdiecker degradation using red mercuric oxide-bromine has been found to be a convenient method for the conversion of bile acids to steroids containing bromo alkyl side-chains.

27824 Evolution of karyotypes in Philadelphia (Ph^1) chromosome-negative chronic myelogenous leukemia. Mintz, U.; Vardiman, J.; Golomb, H.M.; Rowley, J.D. (Univ. of Chicago, IL). Contract EY-76-C-02-0069. *Cancer;* **43**: No. 2, 411-416(Feb 1979).

Ten of 55 patients with chronic myelogenous leukemia (CML) diagnosed between 1972 and 1977 were found to lack the Philadelphia (Ph^1) chromosome. Serial clinical, morphologic, and cytogenetic studies of patients with Ph^1-negative CML showed that 30% of them had chromosomal abnormalities. Two had an extra chromosome No. 8 at the time of blast crisis, with a morphological picture of myeloblasts in the bone marrow. A third patient had a 6:14 translocation initially. Abnormalities of chromosome No. 14 are frequently seen in lymphoproliferative disorders, and the bone marrow and peripheral blood contained a significant population of lymphoblasts as well as myeloblasts. The median survival for the 10 patients was 19 months. The exact nature of Ph^1-negative CML is not yet clear; the disease appears to be a distinct entity among the myeloproliferative disorders.

27825 Extreme sensitivity of enveloped viruses, including herpes simplex, to long-chain unsaturated monoglycerides and alcohols. Sands, J.; Auperin, D.; Snipes, W. (Lehigh Univ., Bethlehem, PA). *Antimicrob. Agents Chemother.;* **15**: No. 1, 67-73(Jan 1979).

Unsaturated monoglycerides and alcohols of chain lengths of 16 to 18 carbons were found to be extremely potent inactivators of two enveloped viruses, herpes simplex virus type 2 and bacteriophage phi 6. The lipid-containing bacteriophage PM2 was also inactivated by some of these amphiphilic molecules. Treatment of herpes simplex virus type 2 with these compounds at concentrations as low as 0.2 μM reduced virus survival to 50% in 30 min, making these agents the most potent inactivators of herpes simplex viruses discovered that are not cytotoxic to mammalian cells. Detailed characterizations of the effects of unsaturated monoglycerides and alcohols on bacteriophages phi 6 and PM2 showed that the inactivated phi 6 virion remained nearly intact but that PM2 was almost completely disrupted by the inactivating treatment. Some of the compounds inactivate the viruses even at low temperature (0°C). Excess amounts of diglycerides and phospholipids interfere with the inactivating abilities of some of the unsaturated monoglycerides and alcohols against phi 6 and PM2. Our findings suggest that the unsaturated monoglycerides and some of the unsaturated alcohols should be further studied as potential antiviral agents. Particularly for application to herpesvirus-infected areas of the skin and accessible epithelium.

27826 Environmental carcinogenesis and imperfect repair of damaged DNA in Homo sapiens: causal relation revealed by rare hereditary disorders. Paterson, M.C. (Atomic Energy of Canada Limited, Chalk River, Ontario). pp 251-276 of Carcinogens: identification and mechanisms of action. Griffin, A.C.; Shaw, C.R. (eds.). New York, NY; Raven Press (1979).

Other contributions in this volume indicate that steady progress is being made in elucidating the chain(s) of events leading to the inception of the cancerous state. This article bears on a particular aspect of the problem, namely, the role of carcinogen-induced damage to DNA and its inefficient enzymatic repair in the initiation of neoplastic transformation. Evidence that such damage to the genetic material can be an etiologic factor stems largely from the discovery that in certain rare genetic disorders, affected individuals are predisposed to cancer and their cells in culture exhibit hallmarks of deficient repair of DNA damage. This association is well documented for the prototype disease, xeroderma pigmentosum (XP), and to a lesser extent for two others, ataxia telangiectasia (AT) and Fanconi's anemia (FA). The primary intention here is to review the current state of knowledge concerning these three diseases, with emphasis on the most recent data, and to discuss the implications of these findings to general theories of environmental carcinogenesis.

UNSEALED RADIONUCLIDES IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 27791, 27819, 27847

27827 Total-body sodium and sodium excess. Aloia, J.F.; Cohn, S.H.; Abesamis, C.; Babu, T.; Zanzi, I.; Ellis, K. (Nassau Hospital, Mineola, NY). *J. Nucl. Med.;* **21**: No. 2, 130-134(Feb 1980).

Total-body levels of sodium (TBNa), chlorine (TBCl), calcium (TBCa), and potassium (TBK) were measured by neutron activation and analysis of results by whole body counting in 66 postmenopausal women. The relationship between TBNa, and TBCl, TBK, and TBCa on the one hand, and height and weight on the other, were found to compare with those previously reported. The hypothesis that TBNa and TBCl are distributed normally could not be rejected. The sodium excess (Na/sub es/) is defined as the sodium that is present in excess of that associated with the extracellular fluid (chlorine) space; the Na/sub es/ approximates nonexchangeable bone sodium. In these 66 postmenopausal women, and in patients with different endocrinopathies previously described, the values on Na/sub es/ did not differ from the normal values except in the thyrotoxicosis patients, where they were decreased. A close relationship between Na/sub es/ and TBCa was maintained in the endocrinopathies studied. This relationship was found in conditions accompanied by either an increment or a loss of skeletal mass. It appears that the NA/sub es/ value is primarily dependent upon the calcium content of bone.

27828 Direct spectroscopic observation of singlet oxygen emission at 1268 nm excited by sensitizing dyes of biological interest in liquid solution. Khan, A.U.; Kasha, M. (Florida State Univ., Tallahassee). *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 12, 6047-6049(Dec 1979).

The direct observation of dye-photosensitized 1268-nm emission of the $^1\Delta$/sub g/ → $^3\Sigma$/sub g/ transition of molecular oxygen in liquid solution at room temperature is reported. Singlet oxygen was photosensitized by uv excitation of perfluorobenzophenone in fluorocarbon solvent, by 3,4-benzpyrene and hematoporphyrin in carbon tetrachloride, and by methylene blue in water. Also reported is the development of an extremely sensitive near-infrared spectrophotometer that uses a thermoelectrically cooled lead sulfide detector, optimized optics, and a boxcar integrator as a data processor.

27829 Selective localization of radiolabeled immune lymphocytes into syngeneic tumors. Mule, J.J.; Jones, F.R.; Hellstroem, I.; Hellstroem, K.E. (Univ. of Washington, Seattle). Contract AT(45-1)-2225. *J. Immunol.;* **123**: No. 2, 600-606(Aug 1979).

Newly formed long-lived small lymphocytes (LLSL) generated during the immunization of mice to tumor specific transplantation antigens (TSTA) of syngeneic MCA-induced sarcomas were labeled. We then studied the localization of these labeled cells into tumor implants. Criss-cross experiments were performed in which MCA sarcomas with individually distinct TSTA were studied in parallel. A selective localization of LLSL into tumors to which the lymphocytes were immune was found when small tumor pieces were implanted into immune mice whose LLSL had been labeled. Selective localization was also detected upon adoptive transfer of immune LLSL to tumor-bearing mice, but only when these mice had, before transfer, received a sublethal dose of whole body irradiation.

EXTERNAL RADIATION IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 27884

EXTERNAL RADIATION IN THERAPY

REFER ALSO TO CITATION(S) 27829, 27852, 27862, 27865

MICROBIOLOGY

REFER ALSO TO CITATION(S) 27057, 27756, 27757, 27758, 27759, 27761, 27763, 27771, 27773, 27779, 27785, 27807, 27810, 27825, 27855, 27856, 27857, 27858

27830 Antipain lethality to Escherichia coli: dependence upon cyclic adenosine 3',5'-monophosphate and its receptor protein. Swenson, P.A. (Oak Ridge National Lab., TN). *J. Bacteriol.;* **139**: No. 2, 690-693(Aug 1979).

Antipain kills Escherichia coli K-12 cells in an exponential manner beginning 1 h after its addition. Mutant strains, Δcya and crp, which are unable to synthesize cyclic adenosine 3',5'-monophosphate (cAMP) and the cAMP receptor protein, respectively, are not affected. Addition of cAMP (5 mM) to antipain-treated mutant strains causes killing of Δcya cells, but not crp cells. Thus the lethal effect of antipain is dependent upon cAMP and its receptor protein.

27831 Beta-2-linked glucans secreted by fast-growing species of Rhizobium. York, W.S.; McNeil, M.; Darvill, A.G.; Albersheim, P. (Univ. of Colorado, Boulder). *J. Bacteriol.;* **142**: No. 1, 243-248(Apr 1980).

Fast-growing species of Rhizobium were found to secrete low-molecular-weight β-2-linked glucans when cultured in synthetic liquid medium. These glucans are quite similar to β-2-linked glucans produced by species of Agrobacterium. No reducing terminus was detected in these glucans.

27832 Rapidly metabolizing pool of phosphatidylglycerol as a precursor for phosphatidylethanolamine and diglyceride in Bacillus megaterium. Lombardi, F.J.; Chen, S.L.; Fulco, A.J. (Univ. of California Medical School, Los Angeles). Contract EY-76-C-03-0012. *J. Bacteriol.;* **141**: No. 2, 626-634(Feb 1980).

Pulse-chase experiments in Bacillus megaterium ATCC 14581 with [U-^{14}C]-palmitate, L-[U-^{14}C]serine, and [U-^{14}C]glycerol showed that a large pool of phosphatidylglycerol (PG) which exhibited rapid turnover in the phosphate moiety (PG/sub t/) underwent very rapid interconversion with the large diglyceride (DG) pool. Kinetics of DG labeling indicated that the fatty acyl and diacylated glycerol moieties of PG/sub t/ were also utilized as precursors for net DG formation. The [U-^{14}C]glycerol pulse-chase results also confirmed the presence of a second, metabolically stable pool of PG (PG/sub s/), which was deduced from [^{32}P]phosphate studies. The other major phospholipid, phosphatidylethanolamine (PE), exhibited pronounced lags relative to PG and DG in ^{14}C-fatty acid, [^{14}C]glycerol, and [^{32}P]-phosphate incorporation, but not for incorporation of L-[U-^{14}C]serine into the ethanolamine group of PE or into the serine moiety of the small phosphatidylserine (PS) pool. Furthermore, initial rates of L-[U-^{14}C]serine incorporation into the serine and ethanolamine moieties of PS and PE were unaffected by cerulenin. The results provided compelling in vivo evidence that de novo PG/sub t/, PS, and PE syntheses in this organism proceed for the most part sequentially in the order PG/sub t/ → PS → PE rather than via branching pathways from a common intermediate and that the phosphatidyl moiety in PS and PE is derived largely from the corresponding moiety in PG/sub t/, whereas the DG pool indirectly provides an additional source for this conversion by way of the facile PG/sub t/ ⇌ DG interconversion.

27833 Isolation of Aeromonas hydrophila from the American alligator, Alligator mississippiensis. Gorden, R.W. (Univ. of Southern Colorado, Pueblo); Hazen, T.C.; Esch, G.W.; Fliermans, C.B. Contract EY-76-S-09-0965. *J. Wildl. Dis.;* **15**: 239-243(Apr 1979).

Aeromonas hydrophila was isolated from the internal organs of nine adult alligators, Alligator mississippiensis, which died without apparent cause, suggesting the bacterium may have been a factor. One hundred and twenty-three alligators ranging in age from six months to over 10 years were captured from five locations in the southeastern United States and sampled for A. hydrophila. The bacterium was isolated from the oral cavity of 85% of the animals, on the external jaw area from over 50% and from 70% of the internal tissue samples. A. hydrophila is ubiquitous with alligators in their natural habitats, but apparently does not cause clinical disease. However, stress factors such as trapping, handling, and warm water tempertures may be conducive to the rapid proliferation of the bacteria, thereby facilitating disease.

27834 Structure of the surface layer protein of the outer membrane of Spirillum serpens. Glaeser, R.M.; Chiu, W.; Grano, D. (Univ. of California, Berkeley). *J. Ultrastruct. Res.;* **66**: 235-242(1979).

The outer membrane of the Gram negative bacterium, Spirillum serpens VHA, possesses an ordered surface-layer protein. A morphological model of this protein is proposed on the basis of electron micrographs that have been obtained of unstained, hydrated specimens as well as of negatively stained specimens. The molecular weight of the protein monomer in this model is consistent with the surface-layer protein molecular weight obtained by gel electrophoresis and estimated to be 140,000. In addition, gel electrophoresis reveals the presence of proteins of MW ≃ 35,000 and MW ≃ 78,000, which remain associated with the outer membrane under conditions where the ordered surface-layer protein is released in soluble form.

27835 Electron microscopy of single-stranded mycoplasmavirus DNA. Nowak, J.A.; Maniloff, J.; Das, J. (Univ. of Rochester, NY). *FEMS Microbiol. Lett.;* **4**: 59-61(1978).

Mycoplasmavirus MVL51 virions are unenveloped bullet-shaped particles, about 14 nm by 80 nm, with helical symmetry. Studies of the effect of various specific nucleases on viral DNA infectivity showed that the MVL51 geonme is circular single-stranded DNA. Viral replication involves two double-stranded DNA replicative forms: RFI, a covalently closed double-stranded circular derivative of the viral DNA, and RFII, a relaxed form of RFI. Previous sedimentation studies of the MVL51 viral single-strand DNA, in this laboratory, indicated the genome size was about 2×10^6 daltons. Since smaller DNA forms are sometimes seen in cell lysates it was decided to reevaluate the viral genome size by electron microscopy. Measurement of double-stranded viral RF DNA by electron microscopy allows a more accurate determination of the molecular weight than was possible by the earlier sedimentation studies.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 27793

27836 Host transcription in bacteriophage P22-infected Salmonella typhimurium. Pipas, J.M.; Reeves, R.H. (Florida State Univ., Tallahassee). *J. Virol.;* **32**: No. 3, 822-831(Dec 1979).

The kinetics of host RNA synthesis, as measured by pulse-label kinetics and RNA-DNA hybridization, is inhibited 10-fold shortly after infection with bacteriophage P22. This early inhibition lasts through the first 6 min of infection and affects not only RNA synthesis but several other energy-requiring cellular functions. In lysogenic infections, the rate of bacterial transcription rapidly recovers to the value of uninfected controls. In lytic infections, the rate of host transcription increases only to about 20 to 25% of the original level, indicating a second mechanism for the inhibition of RNA synthesis in the lytic response. The early inhibition is multiplicity dependent, chloramphenicol insensitive, and independent of phage gene 24. The lytic inhibition is dependent upon the expression of gene 24 but independent of gene 23.

27837 RegA protein of bacteriophage T4D: identification, schedule of synthesis, and autogenous regulation. Cardillo, T.S.; Landry, E.F.; Wiberg, J.S. (Univ. of Rochester, NY). *J. Virol.;* **32**: No. 3, 905-916(Dec 1979).

Proteins labeled with ^{14}C-amino acids after infection of Escherichia coli B by T4 phage were examined by electrophoresis in the presence of sodium dodecyl sulfate. Four regA mutants (regA1, regA8, regA11, and regA15) failed to make a protein having a molecular weight of about 12,000, whereas mutant regA9 did make such a protein; regA15 produced a new, apparently smaller protein that was presumably a nonsense fragment, whereas regA11 produced a new, apparently larger protein. We conclude that the 12,000-dalton protein was the product of the regA gene. The molecular weight assignment rested primarily on our finding that the regA protein had the same mobility as the T4 gene 33 protein, which we identified by electrophoresis of whole-cell extracts of E. coli B infected with a gene 33 mutant, amE1120. Synthesis of wild-type regA protein occurred from about 3 to 11 min after infection at 37°C in the DNA^+ state and extended to about 20 min in the DNA^- state. However, synthesis of the altered regA proteins of regA9, regA11, and regA15 occurred at a higher rate and for a much longer period in both the DNA^+ and DNA^- states; thus, the regA gene is autogenously regulated. At 30°C, both regA9 and regA11 exhibited partial regA function by eventually shutting off the synthesis of many T4 early proteins; the specificity of this shutoff differed between these two mutants. We also obtainedevidence that the regA protein is not Stevens's polypeptide 3. As a technical point, we found that, when quantitating acid-precipitable radioactivity in protein samples containing sodium dodecyl sulfate, it was necessary to use 15 to 20% trichloroacetic acid; use of 5% acid, e.g., resulted in loss of over half of the labeled protein.

27838 Adenovirus type 2 terminal protein: purification and comparison of tryptic peptides with known adenovirus-coded proteins. Harter, M.L.; Lewis, J.B.; Anderson, C.W. (Brookhaven National Lab., Upton, NY). *J. Virol.;* **31**: No. 3, 823-835(Sep 1979).

The protein covalently bound to the 5' termini of adenovirus type 2 DNA has been purified from virus labeled with [^{35}S]methionine, using exclusion chromatography of disrupted virions to isolate the DNA-protein complex, which is then digested with DNase. The terminal protein isolated from mature virus is most effectively labeled if the cells are exposed to [^{35}S]methionine during the intermediate period of 13 to 21 h postinfection, suggesting that the protein is synthesized during this interval. The tryptic peptides of the terminal protein were compared with those of several known adenovirus-coded proteins and found to be unrelated. In particular, the terminal protein is not related to the 38 to 50K early proteins encoded by the leftmost 4.4% of the adenovirus genome, one region essential for the transforming activity of the virus. Neither is it related to the 72K single-strand-specific DNA binding protein, the minor virion component IVa_2, or the major capsid component hexon.

MORPHOLOGY

REFER ALSO TO CITATION(S) 27809, 27834, 27845

27839 Microscopic observations in cuticle from trichomeless, tr, and normal Tr, pearl millet. Hanna, W.W.; Akin, D.E. (Univ. of Georgia, Tifton). Contract EY-76-S-09-0637. *Crop Sci.;* **18**: 904-905(Sep 1978).

Leaves of trichomed (Tr) and trichomeless (tr) pearl millet were studied with both electron and light microscopy to determine morphological differences that may account for the differences in transpiration rate, pest resistance, and penetration of rumen microbes through the leaf surface between the two lines. Slight differences were observed in cuticle thickness. Encrustation of epidermal cell walls in tr cuticle indicate chemical differences between tr and Tr cuticle. The cuticle of Tr plants had 3X and 1.3X as many cracks of the adaxial and abaxial leaf surfaces, respectively, as that of tr plants. This helps to explain why tr leaves transpire less water than Tr leaves and why there is more penetration of rumen microbes through the surface of Tr leaves as compared to tr leaves.

PATHOLOGY

REFER ALSO TO CITATION(S) 27797, 27824, 27833, 27864, 27872, 27875, 27893, 27930, 27939

27840 (BNL—27325) Proton-induces and x-ray induced fluorescence analysis of scoliotic tissue. Panessa-Warren, B.J.; Kraner, H.W.; Jones, K.W.; Weiss, L.S. (Brookhaven National Lab., Upton, NY (USA)). Feb 1980. Contract AC02-76CH00016. 14p. (CONF-800801—6). NTIS, PC A02/MF A01.

From 39. annual meeting of the Electron Microscopy Society of America and the 15. annual meeting of the Microbeam Analysis Society; San Francisco, CA, USA (4 Aug 1980).

Adolescent idiopathic scoliosis is characterized by a curvature or assymetry of the spine which may become progressively more severe, with clinical symptoms appearing just prior to, or during, puberty. The incidence for scoliosis in the age group from 12 to 14 years of age has been reported as high as 8 to 10%, with more than 80% of the cases occurring in females. Although pathologic changes exist in muscles from both sides of the spinal curvature, and no statistically significant side differences have been reported, morphologic changes suggest that the concanve side is the most affected. This paper reports our preliminary data on the elemental composition of individual muscle fibers derived from convex, concave and

gluteal scoliotic muscle, and erythrocytes from scoliotic and normal patients, analyzed by proton induced x-ray emission (PIXE) and x-ray fluorescence spectroscopy (XRF). A new type of specimen holder was designed for this study which offers low x-ray background, minimal absorption and maintenance of a moist environment around the specimen.

27841 Stimulation of mouse megakaryocyte endomitosis by plasma from thrombocytopenic rats. Odell, T.T.; McDonald, T.P.; Shelton, C.; Clift, R. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Proc. Soc. Exp. Biol. Med.;* **160**: No. 2, 263-265(Feb 1979).

Injection of plasma from thrombocytopenic donor rats resulted in an increase in the endomitotic index of megakaryocytes of recipient mice 32 hr after the initial treatment with plasma. The results suggested a dose-response relationship between the amount of plasma administered and the degree of stimulation of megakaryocytopoiesis. These findings demonstrate that an agent capable of stimulating megakaryocytopoiesis is released in response to thrombocytopenia and that this factor can be successfully transferred between species. They also substantiate the assumption that the increase in peripheral platelet numbers and in platelet labeling after administration of presumptive TSF occurs via stimulation of megakaryocytopoiesis.

27842 Vitamin A and the susceptibility of respiratory tract tissues to carcinogenic insult. Nettesheim, P. (Oak Ridge National Lab., TN); Snyder, C.; Kim, J.C.S. *Environ. Health Perspect.;* **29**: 89-93(1979).

The influence of vitamin A on the development of chemically induced lung carcinomas in rats was investigated. Rats were maintained on low, normal, and excess levels of retinyl acetate (RA). Respiratory tract-squamous carcinomas were induced by intratracheal injections f 3-methylcholanthrene (3-MCA). The carcinogen doses used ranged from 1.25 to 10.0 mg of 3-MCA. Serial sacrifices conducted during the first 20 weeks following carcinogen exposure showed that metaplastic lung nodules, presumed to be precursors of later appearing carcinomas, occurred earlier and at a higher incidence in rats maintained on low levels of RA than in rats maintained on moderate or high levels of RA. The development of invasive pulmonary carcinomas was enhanced at all four carcinogen doses in rats receiving low levels of RA as compared to rats receiving moderate or high levels of RA. No consistent difference in lung cancer incidence existed between the groups receiving normal and high levels of RA. The data clearly show an increased susceptibility of vitamin A-deficient rats to develop chemically induced lung cancers. Possible mechanisms underlying this effect are discussed.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 27847, 27928, 27931

27843 Rauscher leukemia as a model for cancer therapy studies. II. Variation in response of splenic CFU-S between normal and Rauscher leukemic mice following exposure to hydroxyurea. Okunewick, J.P.; Meredith, R.F.; Brozovich, B.J.; Seeman, P.R. (Clinical Radiation Therapy Research Center, Pittsburgh, PA). Contract (11-1)-3097. *Proc. Soc. Exp. Biol. Med.;* **163**: No. 1, 132-136(Jan 1980).

Normal mice and mice with advanced Rauscher leukemia were given a single dose of HU and evaluated for the effect of the drug on splenic CFU-S 4 and 16 hr later. Exposure to HU reduced the total number of CFU-S for both normal and leukemic mice by 50% at 4 hr. At 16 hr there was no recovery in CFU-S evident in the normal mouse. However, CFU-S levels in the spleens of the leukemic mice had recovered to nearly that existent before exposure to HU. Effects of HU on total splenic mass differed from that on the CFU-S. Recovery of total splenic mass was seen to have begun in normal animals by 16 hr after HU, while in the leukemic animals spleen size had receded further by 16 hr. The data suggest that, as in man, the hematopoietic recovery responses following exposure to chemotherapeutic drugs may be significantly different in Rauscher viral leukemic mice as compared to normal mice. The possible applicability of Rauscher leukemia as a model for leukemia therapy studies is briefly discussed.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 27708, 27760, 27769, 27794, 27797, 27802, 27820, 27821, 27829, 27839, 27841, 27866, 27924, 27936, 27939, 27942, 27944, 27945, 27946, 27952, 27954, 27955, 27958, 27959, 27960, 27963, 27981, 27982

27844 Macrophages of the mammalian small intestine: a review. LeFevre, M.E. (Brookhaven National Lab., Upton, NY); Hammer, R.; Joel, D.D. *RES, J. Reticuloendothel. Soc.;* **26**: No. 5, 553-573(Nov 1979).

The present review resulted from questions concerning the fate in the intestine of ingested particulate pollutants such as asbestos and fly ash. These and other similar particulates are common contaminants of food and water, but little is known of the hazards associated with their ingestion. It is probable that they present some hazard if they penetrate the intestinal mucosa. In a recent study, fly ash from a coal-burning power plant was found to contain both organic and inorganic mutagens (34). The dangers of asbestos ingestion have been widely discussed (20, 36a, 41, 56, 83, 100, 148, 172, 184), although the extent of asbestos penetration of the intestinal mucosa still uncertain (20, 69, 108, 181). It seemed obvious that many of the particulate pollutants which penetrated the mucosal barrier would be phagocytized by macrophages residing in the lamina propria and that a study of the disposition of particulates within the gut wall should begin with a consideration of intestinal macrophages of lung, pertoneal cavity, spleen and liver have been discussed at length (25), little published work has dealt directly with the origin, abundance and activities of intestinal macrophages. Nevertheless, considerable information on intestinal macrophages and their interactions with materials which reach them from the intestinal lumen is available in publications dealing primarily with other topics. Such information is important in toxicologic studies as well as in studies of host defences to intestinal Ags. It is, therefore, appropriate to assemble and discuss findings on intestinal macrophages, even though at present more questions will be raised than can be answered.

27845 Surface alterations of the mouse zona pellucida and ovum following in vivo fertilization: correlation with the cell cycle. Jackowski, S.; Dumont, J.N. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Biol. Reprod.;* **20**: 150-161(1979).

The zona pellucida and cell surface of in vivo fertilized mouse ova exhibit time dependent changes which can be detected with the scanning electron microscope. The periods of ovulation, fertilization and first cleavage in superovulated C3D2/F_1 hybrids were determined and times corresponding to G_1, S, G_2, and M were calculated. The zona of a mature unfertilized ovum has a rough texture with deep furrows; at fertilization and thereafter the zona develops a smoother, ropy and seemingly porous surface. The cell surface of the unfertilized ovum is characterized by uniform microvilli, small blebs and rounded, mound-like elevations. After fertilization and development to G_1, the ovum loses its blebs but retains the mound-like elevations and microvilli which are now less uniform. As the ovum progresses toward S, it loses the mound-like elevations but retains microvilli in the same density as found in G_1. The ovum in G_2 exhibits smaller but more numerous microvilli which vary considerably in length. Some appear to bifurcate. The fertilized ovum developing through M and G_1 of the 2 cell stage exhibits a less dense population of relatively uniform microvilli, periodic blebs and, again, rounded elevations. The data are reminiscent of surface changes associated with the cell cycle in tissue culture cells and indicate a cyclic progression of the in vivo fertilized mouse ovum through the first cleavage division to the 2 cell stage.

27846 Bioenergetics of the Great Basin pocket mouse, Perognathus parvus. Schreiber, R.K. (Univ. of Idaho, Moscow). *Acta Theriol.;* **23**: No. 32, 469-487(1978).

Ingestion rates and annual energy expenditure for the Great Basin pocket mouse, Perognathus parvus, were studied in south-central Washington (Hanford Reservation) during 1970-1971 as part of the US/IBP Desert Biome program. Food intake models were derived in relation to time, microenvironmental temperatures, metabolic rate, and coefficient of digestibility. Estimated annual ingestion rates were 2550 and 2462 kcal/y for individual males and females, respectively. Summer torpor reduces these costs about 3%. Winter energy expenditure was 40 to 43% lower than summer because of more extensive periods of torpor. Estimated daily maintenance energy requirements ranged from a low of 2.36 and 2.63 kcal in the winter to a high of 6.96 and 6.55 kcal in the spring for individual adult males and females, respectively. These estimates indicate P. parvus consumes between 4 to 10% of its body weight in food per day during the year. Assuming a diet consisting entirely of cheatgrass seeds (Bromus tectorum), individuals require 873 to 999 seeds per day in the spring and summer, decreasing to about 775 seeds per day in the fall. In the winter, facultative torpor reduces this to less than 400 seeds per day, necessitating the caching of approximately 50 to 65 g of seeds. The average annual seed crop would support a maximum density of about 80 animals/ha, indicating this granivore may be periodically food stressed. The overall impact of P. parvus on plant succession at the Hanford site is probably minor.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 27795, 27804, 27843, 27933, 27961, 27964

27847 Effect of plethora on erythropoietin levels. Moccia, G.; Miller, M.E.; Garcia, J.F.; Cronkite, E.P. (Brookhaven National Lab., Upton, NY). Contract EY-C-02-0016; W-7405-ENG-48. *Proc. Soc. Exp. Biol. Med.;* **163**: No. 1, 36-38(Jan 1980).

The mechanism by which plethora suppresses erythropoiesis in experimental animals has been assumed to be related to a decrease in erythropoietin (Ep) levels. Prior to the advent of a radioimmunoassay (RIA) for Ep this theory could not be confirmed because of the insensitivity of the bioassay for Ep. In the present study hypertransfusion induced plethora was associated with approximately a 50% reduction in plasma Ep levels in CF_1 mice.

PUBLIC HEALTH

REFER ALSO TO CITATION(S) 27740, 27815, 27868, 27952, 27973

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 27839

27848 (DOE/SR/01061—2) **Nitrogen fixation in forested soils by non-leguminous nitrogen-fixing plants and by non-symbiotic soil organisms. Progress report, June 1, 1979-May 31, 1980.** Lane, C.L. (Clemson Univ., SC (USA). Dept. of Forestry). May 1980. Contract AS09-78SR01061. 7p. NTIS, PC A02/MF A01.

Field plantings of several species of nitrogen-fixing plants mixed with loblolly pine were measured after two growing seasons on three sites. Survival of loblolly pine was 86%; thorny eleagnus 97%; black alder 58%; and wax myrtle 88%. There was no evidence of an increase in the growth of the loblolly pine caused by the nitrogen-fixing species. Considerable deer browse damage was evident on the thorny eleagnus planted on a deep sand.

27849 Infection and nodulation of clover by nonmotile Rhizobium trifolii. Napoli, C.; Albersheim, P. (Univ. of Colorado, Boulder). Contract EY-76-S-02-1426. *J. Bacteriol.;* **141**: No. 2, 979-980(Feb 1980).

Nonmotile mutants of Rhizobium trifolii were isolated to determine whether bacterial motility is required for the infection and nodulation of clover. The nonmotile mutants were screened for their ability to infect and nodulate clover seedlings in Fahraeus glass slide assemblies, plastic growth pouches, and vermiculite-sand-filled clay pots. In each system, the nonmotile mutants were able to infect and nodulate clover.

27850 Estimation of primary productivity from diel nitrate uptake measurements of the water hyacinth Eichhornia crassipes in an aquaculture system. Hanisak, M.D. (Harbor Branch Foundation, Inc., Ft. Pierce, FL). *Aquaculture;* **19**: No. 1, 75-86(Jan 1980).

The primary productivity of the water hyacinth Eichhornia crassipes was estimated from diel measurements of NO_3-N uptake in an aquaculture system using a continuous, automated nutrient analyzer apparatus. Productivity values obtained by this method agreed favorably with those made by directly harvesting the biomass. Since productivity measurements based on harvesting methods would be impractical on a large scale, the use of diel nutrient uptake measurements would be a significant improvement for proper management of aquatic macrophytes in an aquaculture system. There were few diel changes in NO_3-N uptake by Eichhornia, a fact which is potentially beneficial to this species not only to its ecological success in its natural ecosystem, but also to its ability to remove nutrients as a component in tertiary sewage treatment.

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

27851 UV-endonuclease from calf thymus with specificity toward pyrimidine dimers in DNA. Waldstein, E.A. (Tel-Aviv Univ., Israel); Peller, S.; Setlow, R.B. *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 8, 3746-3750(Aug 1979).

We describe the partial purification of an endonuclease from calf thymus that nicks phage PM2 DNA irradiated with uv doses producing only a few pyrimidine dimers per molecule. It has much less activity on DNA that has been subjected to enzymatic photoreactivation after uv irradiation. The calf thymus endonuclease is different from other mammalian uv-endonucleases so far described in that it seems to be dimer specific. The enzyme is stimulated by Mg^{2+} and is inactive in the presence of EDTA. It binds to uv-irradiated DNA-Sepharose from which it is released by low concentrations of KCl. Gel filtration data indicate that the endonuclease may belong to a high molecular weight protein or protein complex. The enzyme is very labile and freezing increases its lability.

IN MICROORGANISMS

REFER ALSO TO CITATION(S) 27855

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

27852 (UR—3490/LCP-21) **Characterization and evaluation of the response of rat 9L subcutaneous tumors to heat or x rays.** Wallen, C.A. (Rochester Univ., NY (USA). School of Medicine and Dentistry). 1980. Contract AC02-76EV03490. 188p. NTIS, PC A09/MF A01.

Thesis.

The response of a tumor to heat and x irradiation was studied using the rat 9L subcutaneous (sc) tumor model. The relationship of cell survival to tumor cure after hyperthermic treatment is described. Cell survival followed a simple exponential function with a decreasing slope as temperature increased. Except for a small highly sensitive subpopulation, cells from large tumors had the same sensitivity at 44°C as those from small tumors. The radiosensitivity of 9L tumor cells, measured with the colony-forming assay, did not vary with changes in tumor weight, appearance of necrosis, or the use of anesthesia. However, the composite survival curve showed a sensitivity intermediate between and statistically different from that observed either for exponential cells from monolayer cultures, single cells from dissociated tumors, or tumor cells from N_2-asphyxiated rats. Although cellular recovery and perfusion-limited hypoxia are major contributors to the observed radiosensitivity, neither of these factors is probably the sole cause.

27853 Postreplication repair: questions of its definition and possible alteration in xeroderma pigmentosum cell strains. Park, S.D.; Cleaver, J.E. (Univ. of California, San Francisco). *Proc. Natl. Acad. Sci. U.S.A.;* **76**: No. 8, 3927-3931(Aug 1979).

DNA synthesis in normal cells and in excision-defective and variant xeroderma pigmentosum cells was investigated after irradiation with ultraviolet light. The sizes of DNA synthesized during brief pulses of [^{3}H]thymidine 1 to 2 h after irradiation were decreased, the xeroderma pigmentosum variant showing the smallest molecular weight. Once synthesized, however, labeled DNA increased in size at the same rate as control in all cell strains, and the rate was relatively insensitive to caffeine. After 2 to 3 h, labeled DNA in each cell type reached a maximum size that was less than that in control cells, indicating the presence of long-lived blocks to DNA chain growth. This kind of experiment (pulse-chase) has in the past been used to investigate a repair process believed to be associated with the bypass of damaged sites in parental DNA: postreplication repair. We present an alternative model that does not involve a specific postreplication repair mechanism, but involves normal chain elongation and termination mechanisms in which we conceive that dimers and other damaged sites act as all-or-nothing blocks to the progress of replication forks. No evidence could be found for any inducible process that enhanced the bypass of damaged sites.

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

27854 (ORO—4568-26) **Repair and cell cycle response in cells exposed to environmental biohazards. Progress report, June 1, 1979-May 31, 1980.** Billen, D.; Hadden, C.T. (Tennessee Univ., Knoxville (USA); Oak Ridge National Lab., TN (USA)). 1980. Contract AS05-76EV04568. 10p. NTIS, PC A02/MF A01.

Progress is reported in the following research areas: (1) DNA repair in Bacillus subtilis; (2) postreplication repair in Rec$^-$ mutants of B. subtilis; (3) photobiology of halogenated DNA; (4) effects of caffeine on pyrimidine dimer excision and postreplication repair in B. subtilis; and (5) DNA repair in toluene-treated Escherichia coli. (ACR)

27855 In vitro recombination of bacteriophage T7 DNA damaged by uv radiation. Masker, W.E.; Kuemmerle, N.B. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *J. Virol.;* **33**: No. 1, 330-339(Jan 1980).

A system capable of in vitro packaging of exogenous bacteriophage T7 DNA has been used to monitor the biological activity of DNA replicated in vitro. This system has been used to follow the effects of uv radiation on in vitro replication and recombination.

During the in vitro replication process, a considerable exchange of genetic information occurs between T7 DNA molecules present in the reaction mixture. This in vitro recombination is reflected in the genotype of the T7 phage produced after in vitro encapsulation; depending on the genetic markers selected, recombinants can comprise nearly 20% of the total phage production. When uv-irradiated DNA is incubated in this system, the amount of in vitro synthesis is reduced and the total amount of viable phage produced after in vitro packaging is diminished. In vitro recombination rates are also lower when the participating DNA molecules have been exposed to uv. However, biochemical and genetic measurements confirmed that there is little or no transfer of pyrimidine dimers from irradiated DNA into undamaged molecules.

27856 Effects of the rad52 gene on recombination in Saccharomyces cerevisiae. Prakash, S.; Prakash, L.; Burke, W.; Montelone, B.A. (Univ. of Rochester, NY). *Genetics;* **94**: No. 1, 31-50(Jan 1980).

Effects of the rad 52 mutation in Saccharomyces cerevisiae on meiotic, γ-ray-induced, uv-induced and spontaneous mitotic recombination were studied. The rad52/rad52 diploids undergo premeiotic DNA synthesis; sporulation occurs but inviable spores are produced. Both intra and intergenic recombination during meiosis were examined in cells transferred from sporulation medium to vegetative medium at different time intervals. No intragenic recombination was observed at the his1-1/his1-315 and trp-5-2/trp5-48 heteroalleles. Gene-centromere recombination also was not observed in rad/52/rad52 diploids. No γ-ray- or uv-induced intragenic mitotic recombination is seen in rad52/rad52 diploids. The rate of spontaneous mitotic recombination is lowered five-fold at the his1-1/his1-315 and leu1-c/leu1-12 heteroalleles. Spontaneous reversion rates of both his1-1 and his1-315 were elevated 10 to 20 fold in rad52/rad52 diploids. The RAD52 gene function is required for spontaneous mitotic recombination, uv- and γ-ray-induced mitotic recombination and mitotic recombination.

27857 Genetic analysis of gamma-ray mutagenesis in yeast. I. Reversion in radiation-sensitive strains. McKee, R.H.; Lawrence, C.W. (Univ. of Rochester, NY). *Genetics;* **93**: No. 2, 361-373(Oct 1979).

The frequency of revertants induced by ^{60}Co γ rays of the ochre allele, cyc1-9, has been measured in radiation-sensitive strains carrying one of 19 nonallelic mutations and in wild-type strains. The results indicate that ionizing radiation mutagenesis depends on the activity of the RAD6 group of genes and that the gene functions employed are very similar, but probably not identical, to those that mediate uv mutagenesis. Repair activities dependent on the functions of the RAD50 through RAD57 loci, the major pathway for the repair of damage caused by ionizing radiation, do not appear to play any part in mutagenesis. A comparison between the γ-ray data and those obtained previously with uv and chemical mutagens suggests that the RAD6 mutagenic pathway is in fact composed of a set of processes, some of which are concerned with error-prone, and some with error-free, recovery activities.

27858 Genetic analysis of gamma-ray mutagenesis in yeast. II. Allele-specific control of mutagenesis. McKee, R.H.; Lawrence, C.W. (Univ. of Rochester, NY). *Genetics;* **93**: No. 2, 375-381(Oct 1979).

We find that partially different sets of gene functions are required for the production of different kinds of mutations induced by ^{60}Co γ rays in Saccharomyces cerevisiae. This observation is very similar to others made previously with respect to uv mutagenesis and confirms the conclusion that such distinctive patterns of genetic control reflect properties of the test alleles and their genetic locations, rather than the kinds of lesions required to revert them. The data also support the model of mutagenic repair outlined in the first paper of this series in which partially different sets of gene functions are required for the production of different kinds of mutations, the formation of mutations at different genetic sites and the induction of mutations by different mutagens.

RADIATION EFFECTS ON PLANTS

BASIC STUDIES

27859 (BNL—27924) **Radiosensitivity in plants.** Nauman, A.F. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract AC02-76CH00016. 78p. (BIO—3597). NTIS, PC A05/MF A01.

The report presents a compilation of available data on the sensitivity of plants to ionizing radiation, and provides basic information on methods of determining such sensitivities, or of estimating radiosensitivities by calcuation of the nuclear factors upon which they depend. The scope of the data presented here is necessarily limited to the most generally useful radiobiological end points and to the most commonly-used types of radiation. Many of the factors which influence radiosensitivity, particularly nuclear factors, will be discussed. Emphasis will be upon whole-plant studies done at Brookhaven National Laboratory by A.H. Sparrow and his associates, since these studies are the source of most of the available radiosensitivity data and of all the sensitivity predictions listed here. Data presented here include summaries of experimentally-determined radiosensitivities at various end points for both herbaceous and woody higher plants, and for a few species of ferns and lower plants. The algae and fungi have not been considered here due to space limitations.

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 27012, 27743, 27884

27860 (DOE/EV/1830—T5) **Guide to reducing radiation exposure to as low as reasonably achievable (ALARA).** Kathren, R.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract AC06-76RL01830. 233p. NTIS, PC A11/MF A01.

This document is designed to provide DOE contractor personnel with general guidance regarding programs and techniques to reduce radiation exposures to as low as reasonably achievable (ALARA). Thus it is directed towards a broad audience, and should have special relevance and interest for operating management as well as radiation protection personnel. It is well recognized that each contractor has needs specific and critical to its radiation protection program. Hence no single set of specific and detailed criteria can be set down as a prescription for achieving the ALARA goal. Rather, general guidance in the form of broad principles is given in order to acquaint management with ALARA needs and concepts. The purpose is to encourage maximum management support of the technical personnel responsible for carrying out day-to-day radiation protection activities. Although primarily written for management, this document also contains technical guidance of potential value to those directly involved in radiation protection activities. Again it should be stressed that what is provided is guidance, and is therefore not mandatory.

27861 (PNL—3128) **Supplemental report on population estimates for Hanford high-level defense waste draft programmatic environmental impact statement.** Yandon, K.E.; Landstrom, D.K. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76RL01830. 31p. NTIS, PC A03/MF A01.

Current and revised population projections based on those previously published in the document Population Distribution in 90-mile Radius of Hanford Meteorological Station and Projections to Year 2300 by Compass Sector and 10 Mile Radii are presented. In addition, there was a need to extend the population estimates out to 1000 and 10,000 years into the future to permit estimation of population radiation doses from accidents affecting the Hanford Facilities directly related to the defense high-level waste disposal alternatives. The methodology used in making the estimates is presented along with the detailed population matrix data required for performing the dose calculations. Although the near-term overall population projections are probably reasonably correct, no claim is made for the accuracy of the detailed data within each individual sector. Long-term estimates are made using reasonable assumptions about the growth potential and possibilities in the Hanford area. No claim of accuracy of these figures is made since they are so highly dependent on actions and conditions that are not predictable. For example, if a major climate change were to occur, the entire Hanford area might be uninhabited at 10,000 years in the future. To provide conservative dose estimates, it was assumed that the Hanford population will experience reasonable and continuous growth throughout the 10,000 year period.

27862 Radiotherapy of primary brain stem tumors. Kim, T.H.; Chin, H.W.; Pollan, S.; Hazel, J.H.; Webster, J.H. (McGill Univ., Montreal, Quebec). *Int. J. Radiat. Oncol., Biol. Phys.;* **6**: No. 1, 51-57(Jan 1980).

From American Society of Therapeutic Radiologists annual meeting; Los Angeles, CA, USA (31 Oct 1978).

This paper presents results of treatment for 80 patients with primary brain stem tumors who were seen at McGill University Hospitals from 1960 to 1975. A large proportion of the patients were under 15 years old. The majority of pretreatment diagnoses were based on neuroradiologic procedures. The correlation of these procedures in histologically verified cases is high. Glioblastoma comprised 38.7% of the histologically proven cases. Radiotherapy was the main modality of the treatment. Of the patients who received over 5000 rad, 44/63 (39.8%) survived at 3 years, 34.5% at 5 years and 28.4% at 10 years. This result is similar to that in Bouchard's series which analyzed the cases from the same source prior to this series. The initial response to treatment was beneficial in the majority of patients and this early response appears to be a dependable prognostic parameter.

VERTEBRATES

REFER ALSO TO CITATION(S) 27813, 27829, 27905

27863 (PNL—3300(Pt.1), pp 164-165) **Total body exposure of newborn rats in ^{85}Kr atmospheres.** DeFord, H.S.; Ballou, J.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Newborn rats exposed 230 to 4800 rad total body radiation from ^{85}Kr developed radiation dermatitis, and showed stunted growth and abnormal development of ears, eyelids, and paws. A dose of 1000 rad was tolerated without grossly observable effect.

27864 (PNL—3300(Pt.1), pp 234-235) **Use of nude mice for growth and evaluation of radiation-induced tumors.** Frazier, M.E.; Andrews, T.K.; McDonald, K.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Heterotransplantation of cell cultures, derived from radiation-induced tumors, into nude mice indicates that this technique can be a useful tool in determining the malignancy potential of these cells. However, the route of inoculation of these tumor cells is an important factor in determining the transplantability of such cells.

27865 (PNL—3300(Pt.1), pp 236-237) **Fully portable blood irradiator.** Hungate, F.P.; Riemath, W.F.; Bunnell, L.R. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

A fully portable blood irradiator was developed using the beta emitter thulium-170 as the radiation source and vitreous carbon as the body of the irradiator, matrix for isotope encapsulation, and blood interface material. These units were placed in exteriorized arteriovenous shunts in goats, sheep, and dogs and the effects on circulating lymphocytes and on skin allograft retention times measured. The present work extends these studies by establishing baseline data for skin graft rejection times in untreated animals.

27866 **Nonspecific suppressor elements in murine allogeneic radiation chimeras.** Urso, P.; Gengozian, N. (Oak Ridge Associated Universities, TN). *Cell. Immunol.;* **47**: No. 1, 19-31(15 Sep 1979).

Spleen cells from long-term mouse allogeneic radiation chimeras were tested for their ability to modulate the graft-versus-host (GVH) or plaque-forming cell (PFC) response of normal lymphocytes transplanted in lethally x-irradiated recipients. In vivo GVH proliferation of normal lymphocytes (syngeneic to donor cells of the chimera) against antigens of host-type in which the chimeric state had been established was reduced by chimera cells. Inhibition varied, some chimeras suppressing GVH more than others and a few not suppressing at all. The suppressive effect was abrogated if the chimera cells were treated with anti-THETA; treatment with anti-IgM did not eliminate this activity. When mixtures of normal donor lymphocytes and chimera cells were given to irradiated recipients genetically different from host or donor, reduction of donor cell GVH also occurred. Further, chimera cells reduced the GVH activity of normal host cells in irradiated recipients differing from the host at one H-2 locus and from the donor at minor histocompatibility loci. The modulating effect of spleen cells from chimeras on the PFC response by normal lymphocytes also varied. Six chimeras induced a 25 to 90% suppression, two enhanced the response, and one showed no effect. Where suppression occurred, treatment of chimera cells with anti-THETA most often, but not always, restored PFC production. Our results show that the suppressive action of splenic lymphoid cells by chimeras is highly nonspecific and variable in expression. We suggest that tolerance in chimeras may be mediated by nonspecific suppressor elements leading to unresponsiveness to a variety of antigens including SRBC.

BASIC STUDIES

27867 **Excision deficiency in the mutagen-sensitive mus (2) 201/sup D1/ mutant of Drosophila.** Boyd, J.B. (Univ. of California, Davis). Contract AT(04-3)34. *Genetics;* **91**: No. 4, S13(1979).

Selection for mutants that are sensitive to chemical mutagens was conducted with the aid of stocks bearing translocations between the two major autosomes of Drosophila melanogaster. A mutant linked to the second chromosome has been designated mus (2) 201 / sup D1/. Larvae homozygous for this mutation are hypersensitive to methyl methanesulfonate, nitrogen mustard and 2-acetylaminofluorene. Analyses of DNA repair in primary cell cultures derived from homozygous mus (2) 201/sup D1/ embryos have revealed a strong deficiency for the excision of pyrimidine dimers. This defect has been detected by monitoring the resynthesis step of excision repair with unscheduled DNA synthesis. Complete retention of pyrimidine dimers in the DNA of irradiated mutant cells has also been demonstrated during post-irradiation incubation. During this same period cells from control stocks remove about 60% of the induced lesions from their DNA. Pyrimidine dimers were detected in this assay as sites sensitive to a uv-specific endonuclease preparation. Alkaline elution analysis has detected the induction of incision-related DNA breaks in control cells but not in mus (2) 201/sup D1/ cells following uv irradiation. In wild type cells the frequency of uv-induced breaks is elevated by inhibitors of DNA synthesis. This accumulation of breaks is not observed in mus (2) 201/sup D1/ cells. We, therefore, conclude that this mutant is deficient in the initial incision step of excision repair. DNA synthesis, postreplication repair and the repair of single strand breaks induced by x-rays are normal in this mutant.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

REFER ALSO TO CITATION(S) 27743

27868 **Study of radioactivity and health status of former thorium worker: preliminary report.** Rundo, J.; Polednak, A.P.; Brues, A.M.; Lucas, H.F. Jr.; Patten, B.C.; Rowland, R.E.; Stehney, A.F. (Argonne National Lab., IL). *Environ. Res.;* **18**: 94-100(1979).

Studies have been started of the late effects of thorium on the health of a population of 4316 persons (80% males) who worked at a thorium refinery during the period from the mid-1930s to 1973. The population and the study are described briefly, as are the methods and results to date of measurements of radioactivity in vivo and in the exhaled breath. Of 46 men examined so far, all but three had readily measurable amounts of thoron in the breath, but there was little correlation between the amount of activity in the breath and the ^{212}Bi content of the chest.

ANIMALS

REFER ALSO TO CITATION(S) 27885, 27890, 27891, 27892, 27898, 27899, 27901, 27952

27869 (PNL—3300(Pt.1), pp 87-94) **Dose-effect studies with inhaled plutonium oxide in beagles.** Park, J.F.; Case, A.C.; Catt, D.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Beagle dogs given a single exposure to $^{239}PuO_2$ and $^{238}PuO_2$ aerosols are being observed for life-span dose-effect relationships. The ^{239}Pu body burden of the nine dogs that died of pulmonary-fibrosis-induced respiratory insufficiency during the first 3 yr after exposure was 1 to 12 μCi; one of these dogs had a pulmonary tumor. Seventeen additional dogs, with body burdens of 0.2 to 1.8 μCi, died due to pulmonary neoplasia 3 to 8 yr after exposure. Ten of the dogs exposed to ^{238}Pu have died during the first 5 1/2 yr postexposure due to bone and/or lung tumors; the body burden at death ranged from 1.5 to 10 μCi. Lymphopenia was the earliest observed effect after inhalation of $^{239}PuO_2$ or $^{238}PuO_2$, occurring 0.5 to 2 yr after deposition of >80 nCi plutonium in the lungs.

27870 (PNL—3300(Pt.1), pp 95-96) **Data storage and retrieval for long-term dog studies.** Watson, C.R.; Trauger, G.M.; McIntyre, J.M.; Slavich, A.L.; Park, J.F. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Over half of the 500,000 records collected on dogs in the last 20 years in our laboratory have been converted from sequential storage on magnetic tape to direct-access disk storage on a PDP 11/70 minicomputer. An interactive storage and retrieval system, based on a commercially available query language, has been developed to make these records more accessible. Data entry and retrieval are now performed by scientists and technicians rather than by keypunch operators and computer specialists. Further conversion awaits scheduled computer enhancement.

27871 (PNL—3300(Pt.1), pp 99-104) **Dose-effect studies with inhaled plutonium nitrate in dogs.** Dagle, G.E.; Cannon, W.C.; Case, A.C.; Madison, R.M.; McShane, J.F.; Stevens, D.L.; Rowe, S.E.; Ragan, H.A.; Schirmer, R.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Beagle dogs given a single inhalation exposure to $^{239}Pu(NO_3)_4$, and observed for life-span dose-effect relationship, died from radiation pneumonitis (four of five at the highest dosage level, in 14 to 25 mo postexposure; 1 of 20 at the medium-high dosage level, at 34 mo postexposure). There were also indications in these dogs of radiation osteosis, characterized by peritrabecular fibrosis. One dog, at 39 mo postexposure, has radiographic evidence of an

osteosarcoma. Leukopenia, lymphopenia, neutropenia and decreased numbers of circulating monocytes and eosinophils occurred at the two highest dosage levels, as previously reported (Annual Report, 1978). Twelve dogs given a single inhalation exposure to $^{239}Pu(NO_3)_4$ showed a more rapid translocation of $^{239}Pu(NO_3)_4$ to bone and liver than was observed for $^{239}Pu(NO_3)_4$, but at 1 yr postexposure the percentage of the final body burden in bone and liver were similar for the two isotopes.

27872 (PNL—3300(Pt.1), pp 105) **Interactive storage and retrieval of pathologist's observations.** Trauger, G.M.; Dagle, G.E.; Watson, C.R.; McIntyre, J.M. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

A system was developed for interactive storage and retrieval of pathologic observations. Data are entered on a CRT terminal using modified SNOP (Systematized Nomenclature of Pathology) codes. They are then stored and processed in a PDP 11/70 computer, and are retrieved on demand, utilizing DATATRIEVE and a variety of reports convenient for statistical analysis.

27873 (PNL—3300(Pt.1), pp 106) **Effect of vitamin C on pulmonary carcinogenesis from inhaled $^{239}PuO_2$.** Sanders, C.L.; Conklin, A.W. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Vitamin C is being tested as a possible agent to minimize lung cancer induction from inhaled $^{239}PuO_2$.

27874 (PNL—3300(Pt.1), pp 111-113) **Quantitative study of pulmonary lesions and epithelial proliferation following inhalation of $^{239}PuO_2$ in rats.** Rhoads, K.; Adee, R.R.; Sanders, C.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Morphometric analyses of lung parenchyma exposed to $^{239}PuO_2$ indicated a volumetric increase in pulmonary fibrosis, epithelial metaplasia, and neoplasia with increasing time after exposure. Metaplastic and neoplastic lesions usually occupied less than 1% of the total lung volume.

27875 (PNL—3300(Pt.1), pp 114-115) **Transplantation of hamster lung lesions induced by $^{239}PuO_2$ or benz(a)pyrene.** McDonald, K.E.; Sanders, C.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

None (0%) of 1000 recipients of lung lesions for $^{239}PuO_2$-exposed hamsters that were transplanted into other hamsters' cheek pouches, developed tumors, whereas 90% of transplants from benz(a)pyrene-induced lung lesions were malignant.

27876 (PNL—3300(Pt.1), pp 152-153) **Influence of radon-daughter exposure rate and uranium ore dust concentration on occurrence of lung tumors.** Cross, F.T.; Palmer, R.F.; Busch, R.H. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Groups of male SPF Wistar rats were exposed concurrently to several levels of radon daughters and uranium ore dust to study the effect of these variables on pulmonary disease states. Clinical pathology data at 1 yr postexposure indicate no significant differences among exposed animals when compared with controls. Preliminary histopathologic data suggest a trend toward increasing lung tumor risk as the exposure rate is decreased (constant total dose), but the differences are not statistically significant at the 0.05 level. A similar trend occurs with decrease in ore dust concentration (except for the 2560-WLM exposure group), but these differences are also not significant at the 0.05 level. The tumor risk is significantly (0.05 level) increased as the exposure level increases from approximately 320 and 640 WLM to 2560 WLM at the high ore dust concentration (15 mg/m^3).

27877 (PNL—3300(Pt.1), pp 154-156) **Pulmonary function evaluations of dogs exposed to uranium ore dust.** Loscutoff, S.M.; Buschbom, R.L.; Palmer, R.F.; Cross, F.T. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Pulmonary function evaluations were conducted on dogs exposed to carnotite uranium ore dust. Significant changes were detected in the slope of the single-breath N_2 washout curve, suggesting an uneven distribution of ventilation.

27878 (PNL—3300(Pt.1), pp 161-163) **Effect of chronic ^{85}Kr exposure.** Willard, D.H.; DeFord, H.S.; Ballou, J.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Groups of rats exposed continuously for 15 mo to ^{85}Kr atmospheres have received measured dose rates of 2750, 370, and 38 rad/yr. With more than 75% of the rats still alive, there has been no dose-related effect on weight gain but a probably significant effect on survival.

27879 (PNL—3300(Pt.1), pp 183-185) **Late effects of ^{239}Pu injection in adult, weanling, newborn, and fetal rats.** Sikov, M.R.; Mahlum, D.D.; Zwicker, G.M.; Hess, J.O.; Carr, D.B. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Exposure to Pu decreased the latency of mammary tumor induction in all age groups; incidence varied with the age at injection, and with the dose. There were age-related differences in the effect of plutonium exposure on pituitary tumor incidence, as well as an association between the presence of both mammary and pituitary tumors. Prenatal exposure also increased the incidence of adrenal and pancreatic neoplasms in males.

27880 (PNL—3300(Pt.1), pp 189-192) **Effects of pregnancy and lactation on the toxicity of ^{239}Pu.** Mahlum, D.D.; Hess, J.O.; Sikov, M.R. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Nulliparous, pregnant, or lactating Wistar rats were injected intravenously with 0, 0.5 or 2.0 μCi of ^{239}Pu per kilogram of body weight. Half of each group were repeatedly bred while the others were held for observation without further treatment. Treatment with either dose of ^{239}Pu decreased the median time to appearance of mammary tumors. Repeated breeding tended to increase the mean time to appearance. Longevity was decreased in a dose-related fashion by Pu administration. Repeated breeding did not influence survival in a major way.

27881 (PNL—3300(Pt.1), pp 224-225) **Characterization of peripheral-blood lymphocytes in lymphocytopenic dogs exposed to $^{239}PuO_2$.** Morris, J.E.; Graham, T.; Park, J.F. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Mitogen stimulation assays of canine peripheral-blood lymphocytes in whole-blood and density-gradient-isolated lymphocyte cultures showed that a functional decrease had occurred in these lymphocyte populations from plutonium-exposed dogs, suggesting an alteration in immunocompetence.

27882 (PNL—3300(Pt.1), pp 226-228) **In vitro cell-mediated immunity studies of plutonium-exposed beagle dogs.** Morris, J.E.; Graham, T.; Park, J.F. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Mitogen-induced activation was measured in spleen and mesenteric lymph node cell preparations from dogs exposed to a single inhalation exposure of plutonium oxide (^{238}Pu or ^{239}Pu). Reduced stimulation indices of splenic lymphocytes from exposed animals suggest that a reduction in lymphocyte function has occurred in this tissue. No apparent reduction in mitogen stimulation indices was observed in mesenteric lymph node cultures.

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 27720, 27721, 27722, 27723, 27724

27883 (CONF-800607—38) **Dose-rate conversion factors for external exposure to photons and electrons.** Kocher, D.C. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 5p. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

This paper describes recent modifications of the computer code DOSFACTER, which was developed for the purpose of estimating dose-rate conversion factors for external exposure to photons and electrons emitted by radionuclides dispersed in the environment. The modifications and additions which have been made to the calculations outlined above include the following: (1) calculation of electron dose-rate factors for radiosensitive portions of the skin; (2) incorporation of improved estimates of organ dose-rate factors for photons; and (3) calculation of dose-rate factors for additional radio nuclides and incorporation of updated radioactive

decay data for all radionuclides. The revised dose-rate factors described in this paper are available upon request from the Radiation Shielding Information Center at Oak Ridge National Laboratory.

27884 (DOE/ER/02401—T1) **Radioiostope studies utilizing a low level whole body counter and clinical application of activation analysis. Progress report.** Brill, A.B.; Price, R.R. (Vanderbilt Univ., Nashville, TN (USA). Medical Center). 16 Jan 1980. Contract AS05-76ER02401. 26p. NTIS, PC A03/MF A01.

The main emphasis of these studies is the development of methods (hardware and software) for the quantitation of body and specific organ burdens of radioactivity. Current work is directed toward the evaluation of radiation dose distributions in human beings from new radioactive tracers and new procedures used in nuclear medicine. Dosimetry and clinical studies will be carried out on patients using new radiopharmaceuticals where dosimetry data are lacking. Future efforts will be directed toward the development of systems that will facilitate the collection of dosimetry data using less specialized facilities. The availability of instrumentation and analytic techniques that provide clinical images as well as dosimetry data should enhance the rate of collection of data on human exposures in medicine and assist in the optimization of diagnostic strategies. In parallel with these efforts, we are developing a new computer assisted technique for diagnostic decision making. The basic aim is to utilize efficiently all the available data to maximize information gain while minimizing cost factors.

ANIMALS

REFER ALSO TO CITATION(S) 27576, 27871, 27874, 27953

27885 (PNL—3300(Pt.1)) **Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.** (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1980. Contract EY-76-C-06-1830. 353p. NTIS, PC A16/MF A01.

Separate abstracts were prepared for the 101 individual papers presented in this annual report. (ERB)

27886 (PNL—3300(Pt.1), pp 10) **Tissue burdens of ^{210}Pb administered to iron-deficient rats by inhalation.** Ragan, H.A.; Pipes, M.J.; Blanton, E.F.; Klopfer, S.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Iron deficiency did not enhance the pulmonary absorption of inhaled lead.

27887 (PNL—3300(Pt.1), pp 107-110) **Distribution of inhaled $^{239}PuO_2$ in rat and hamster lung.** Rhoads, K.; Mahaffey, J.A.; Sanders, C.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Differences were observed in the spatial-temporal distribution of inhaled $^{239}PuO_2$ in the lung which may contribute to differences in lung tumor response between rats and hamsters.

27888 (PNL—3300(Pt.1), pp 116) **Fate of pulmonary deposited $^{237,239}PuO_2$.** Sanders, C.L.; Conklin, A.W. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

A ^{237}Pu tag is bing tested as a means of rapid analysis for $^{239}PuO_2$.

27889 (PNL—3300(Pt.1), pp 117) **Influence of inhaled cadmium oxide on alveolar clearance of PuO_2 particles.** Sanders, C.L.; Conklin, A.W. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Cadmium oxide inhaled 24 hr or 1 wk previously, reduced the alveolar clearance rate of inhaled $^{239}PuO_2$ particles.

27890 (PNL—3300(Pt.1), pp 120-124) **Inhalation toxicology of $^{241}Am(NO_3)_3$.** Ballou, J.E.; Gies, R.A.; Beasley, A.H. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Inhaled $^{241}Am(NO_3)_3$ was rapidly cleared from the lung (90% in 30 days) and translocated principally to skeleton. Although the estimated radiation dose to lung was twofold greater than the bone dose, the principal treatment-related lesion appeared to be osteosarcoma of the skeleton.

27891 (PNL—3300(Pt.1), pp 125) **Inhalation toxicology of repeated exposures to $^{244}CmO_2$.** Sanders, C.L.; Rhoads, K.; Conklin, A.W. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Rats have been exposed to inhaled $^{244}CmO_2$ at 70 and 280 days of age (IAD, ~ 350 nCi) and at ten 3-week intervals (IAD, ~ 35 nCi per exposure). Autoradiographs are being examined for lung, liver and bone microdosimetry.

27892 (PNL—3300(Pt.1), pp 126-127) **Comparison of metabolism and late effects in dogs and rats exposed to $^{239}PuO_2$.** Mahaffey, J.A.; Sanders, C.L.; Park, J.F.; Dagle, G.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Lung tumors were observed proportionally earlier in relation to expected life span in dogs than in rats after inhalation of $^{239}PuO_2$. Dogs appear to translocate a higher percentage of initial lung burden to liver, skeleton and thoracic lymph nodes than rats.

27893 (PNL—3300(Pt.1), pp 128-130) **Effects of cigarette smoke exposure on pulmonary clearance of $^{239}PuO_2$ in rats.** Filipy, R.E.; Pappin, J.L.; Stevens, D.L.; Irby, S.G. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Groups of rats were exposed or sham exposed to cigarette smoke for 7 mo, at which time they were exposed to an aerosol of $^{239}PuO_2$. Rats were then subjected to whole-body counting (17-keV X-rays) periodically, beginning at day 4 after plutonium exposure, and smoke exposures or sham exposures were resumed on day 7. Clearance of plutonium from the lungs of cigarette-smoke-exposed rats was significantly slower than that from the sham-exposed rats' lungs. The difference between the two groups became significant 7 days after the resumption of cigarette-smoke exposures.

27894 (PNL—3300(Pt.1), pp 131-134) **Biological behavior of mixed LMFBR-fuel-sodium aerosols in rodents.** Mahlum, D.D.; Hess, J.O.; Hackett, P.L.; Briant, J.K. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Clearance of ^{239}Pu from lung and other tissues was determined after nose-only exposure of rats to mixed aerosols of sodium-LMFBR fuel or to LMFBR fuels only. The rates of clearance from lung and from total body were both higher after exposure to the mixed sodium-fuel than after exposure to fuel-only aerosols.

27895 (PNL—3300(Pt.1), pp 135-136) **Deposition and cross-placental transfer of LMFBR fuel-sodium aerosols in rats.** Hackett, P.L.; Hess, J.O.; Mahlum, D.D.; Briant, J.K. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Pregnant rats in late gestation were exposed to aerosols of LMFBR fuel or sodium fuel to determine the deposition and distribution of ^{239}Pu within the fetoplacental unit: 0.008% of the initial body burden of the dam appeared in the fetus immediately after exposure, in both treatment groups; however, a larger fraction of the burden was apparently present in the sodium-fuel-exposed fetuses after 48 hr.

27896 (PNL—3300(Pt.1), pp 137-138) **Effect of exposure sequence on the distribution of LMFBR-fuel-sodium aerosols in rats.** Mahlum, D.D.; Hess, J.O.; Hackett, P.L.; Briant, J.K. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Female Wistar rats were exposed for 30 min to sodium aerosols containing approximately 370 μg/l of sodium. Together with nonexposed rats, they were then exposed, nose-only, for 30 min to aerosols of LMFBR fuel containing approximately 36 nCi/liter. Animals from each group were killed immediately after exposure to the fuel aerosol, or 7 days later. Lungs and other tissues were removed and analyzed for plutonium content. Both the animals exposed previously to sodium aerosol, and those not exposed, showed similar patterns of deposition and retention of ^{239}Pu in tissues at both time periods. Thus, prior exposure of animals to relatively high levels of sodium did not affect the deposition and retention of ^{239}Pu.

27897 (PNL—3300(Pt.1), pp 139-142) **Deposition of inhaled LMFBR-fuel-sodium aerosols in beagle dogs.** Hackett, P.L.; Mahlum, D.D.; Briant, J.K.; Catt, D.L.; Peters, L.R.; Clary, A.J. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Initial alveolar deposition of LMFBR-fuel aerosols in beagle dogs amounted to 30% of the inhaled activity, but only 5% of the total inhaled activity was deposited in dogs exposed to sodium-fuel

aerosols. Aerosol deposition in the gastrointestinal tract amounted to 4% of the initial body burden of fuel-aerosol exposed dogs and 24% of the burden of animals receiving sodium-fuel aerosols. Preliminary analytical data for the dog exposures appear to agree with rodent data for deposition and distribution patterns of aerosols of similar sodium: fuel ratios.

27898 (PNL—3300(Pt.1), pp 166-168) **Disposition and late effects of inhaled $^{232}UO_2(NO_3)_2$ and $^{233}UO_2(NO_3)_2$ in rats.** Ballou, J.E.; Gies, R.A.; Case, A.C. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

^{232}U and ^{23}U appeared to be metabolized similarly in rats except for an unexplained greater lung retention of ^{232}U in one dose group. Retention in skeleton was similar for the two isotopes. Preliminary results indicate that ^{232}U and $^{23}\#U$ are about equally effective in inducing lung tumors.

27899 (PNL—3300(Pt.1), pp 169-174) **Comparative toxicology of inhaled actinide nitrates in rats.** Ballou, J.E.; Gies, R.A.; Beasley, A.H. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

A preliminary comparison of data being obtained on the metabolism, cumulative radiation dose, and tumorigenesis of actinide nitrates in rats suggests there is no unusual toxicity associated with the inhalation of high-specific-activity uranium isotopes (^{233}U and ^{232}U) compared to the toxicity of other inhaled actinide nitrates.

27900 (PNL—3300(Pt.1), pp 175-177) **Uranium removal therapy.** Gies, R.A.; Ballou, J.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Therapeutic treatment regimens used in this study, including DTPA, $NaHCO_3$, sodium salicylate, and combinations of these agents, were notably ineffective in uranium removal.

27901 (PNL—3300(Pt.1), pp 178-179) **Preliminary investigation of the acute toxicity of uranium isotopes.** Gies, R.A.; Ballou, J.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

The acute toxicity of ^{233}U in the rat is due primarily to heavy-metal toxicity rather than to radiation effects.

27902 (PNL—3300(Pt.1), pp 186-188) **Interactions of animal age and particle size with deposition and retention of inhaled ^{51}Cr-labeled microspheres.** Hackett, P.L.; Sikov, M.R.; Skiens, W.E.; Cannon, W.C.; Hess, J.O.; Hall, D. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Newborn, juvenile, weanling, and adult rats were exposed to aerosols of ^{51}Cr-labeled microspheres with AMADs of 0.91, 1.4, 2.3, 3.4, and 4.4 μm. Alveolar deposition was negligible in newborn rats for all particle sizes, and decreased to less than 6% at an AMAD of 2.3 μm in juveniles and weanlings, and an AMAD of 3.4 μm in adults.

27903 (PNL—3300(Pt.1), pp 193-194) **Transplacental absorption of ^{238}Pu in rats and guinea pigs.** Sullivan, M.F. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Pregnant rats and guinea pigs were injected intravenously with ^{238}Pu citrate to determine if the potential for in utero accumulation of ^{239}Pu by these two species is related to the stage of development at which immunity is gained. Although guinea pigs retained more ^{238}Pu after birth than rats, the difference was not significant.

27904 (PNL—3300(Pt.1), pp 195-200) **Species variability in the gastrointestinal absorption and distribution of soluble or insoluble compounds of plutonium.** Sullivan, M.F.; Gorham, L.S.; Blanton, E.F. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Absorption of plutonium was measured after administration to neonatal rats, dogs, and swine by gavage or inhalation. The amount absorbed was not appreciably different for any of the three species, but absorption of the soluble nitrate form was 1000 times higher than that of the insoluble oxide. The higher quantities of ^{238}Pu absorbed and retained in the GI tract of swine suggested that solubilization of the oxide in the lung may have caused the increase. Studies with the more insoluble $^{239}PuO_2$ also resulted in increased retention.

27905 (PNL—3300(Pt.1), pp 201-204) **Effect of x irradiation or chelate administration on transport of plutonium across rat intestine.** Sullivan, M.F.; Gorham, L.S. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Experiments carried out after abdominal x irradiation indicated increased permeability of the gastrointestinal tract to ^{238}Pu at doses of 800 rad or above. Measurement of movement of ^{238}Pu from the isolated duodenum also indicated increased ^{238}Pu transport after 800 to 1500 rad. By the same technique, we were able to show that the increased urinary excretion of ^{239}Pu measured after gavage with ^{239}Pu-DTPA by Baxter and Sullivan (Health Phys. 22: 785, 1972) was indeed due to increased transport across the FI tract. Bile, however, had no measurable effect on ^{238}Pu transport.

27906 (PNL—3300(Pt.1), pp 205-206) **Transport of plutonium across isolated segments of the intestine of neonatal swine.** Sullivan, M.F.; Gorham, L.S. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Absorption of ^{239}Pu was measured in neonatal swine gavaged with either $^{239}Pu(IV)$ or $^{239}Pu(VI)$ nitrate 1 day after birth. When they were killed, 1 or 3 wk later, retention of the Pu(VI) was about 50% greater than retention of Pu(IV). Studies with isolated intestinal segments indicated no appreciable difference in ^{238}Pu transport by the duodenum, midgut or terminal ileum, and a substantial decrease in absorption between 2 and 19 days after birth.

27907 (PNL—3300(Pt.1), pp 207-209) **Effect of oxidation state on the distribution of inhaled ^{239}Pu.** Sullivan, M.F.; Ryan, J.L.; Gorham, L.S.; Blanton, E.F.;. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Rats were exposed to aerosols of $^{239}Pu(IV)$ and Pu(VI) to determine whether the more soluble hexavalent form was more readily absorbed from the lung and/or from the intestine after lung clearance. Some of the animals were fasted to minimize reduction of $^{239}Pu(VI)$ in the gastrointestinal tract. There was a threefold increase in absorption of $^{239}Pu(VI)$ over $^{239}Pu(VI)$ that was not affected by fasting.

27908 (PNL—3300(Pt.1), pp 210-211) **Solubilization of $^{241}AmO_2$ in alveolar macrophage cultures.** Robinson, A.V.; Schneider, R.P. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Cultured rabbit alveolar macrophages were used to study the effect of phagocytosis on the solubilization of $^{241}AmO_2$. A comparison was made of the solubility of phagocytized AmO_2 and AmO_2 in cell-free media, in the presence and absence of 0.1 mM DTPA. A time-dependent increase of 26% in the soluble (0.1-μm filtrate) intracellular americium fraction was seen in macrophages cultured for 3 days. The addition of 0.1mM DTPA to culture medium resulted in an increase of 36% over the same time period. In contrast, cell-free media without DTPA resulted in less than a 2% increase in solubility after 4 days of incubation, while addition of 0.1mM DTPA resulted in a 5% increase over the same time period. These results indicate cell-mediated solbuilization of phagocytized AmO_2 by macrophages.

27909 (PNL—3300(Pt.1), pp 218-219) **Solubilization of $^{241}AmO_2$ in siderophore solutions.** Robinson, A.V. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

The solubilization of $^{241}AmO_2$ in tissue culture medium was measured. Variables included serum concentration, chelon type, and time. Serum was found to affect the soluble (0.1 μm filterable) fraction more than any other variable.

PLANTS

27910 **Factors affecting the availability of americium-241 to the rice plant.** Adriano, D.C. (Savannah River Ecology Lab., Aiken, SC). Contract EY-76-C-09-0819. *J. Agric. Food Chem.;* **27**: No. 6, 1369-1375(Nov 1979).

Since there has been no published transuranic uptake data on the rice plant (Oryza sativa L.), greenhouse experiments were conducted to determine the effects of some factors on the uptake of ^{241}Am by this crop. Results indicate that chelated ^{241}Am (in the form of americium-241-diethylenetriaminepentaacetic acid) applied to the flood water was markedly taken up by the rice plant, compared to the nonchelated form. However, most of the accumulation of ^{241}Am occurred in the vegetative parts and only trace amounts, if any, were translocated to the grain. Soil application of ^{241}Am

resulted in much lower uptake. Soil amendment with either diethylenetriaminepentaacetic acid (DTPA) or organic matter did not produce a discernible uptake pattern. A synthesis of published data on plant uptake of ^{241}Am indicates that the concentration ratio (CR, a measure of availability of ^{241}Am to the plants) values for ^{241}Am for agricultural crops ranged from 10^{-6} to 10^{1} (from lowest to highest availability). Some factors that appear to influence ^{241}Am uptake are as follows: plant parts (grain usually having lower CR), chelating agents (DTPA usually increasing the CR), organic matter (inconsistent effects although generally decreasing the CR), and lime (usually decreasing the CR).

THERMAL EFFECTS

CELLS

REFER ALSO TO CITATION(S) 27852

MICROORGANISMS

27911 (DP-MS—80-64) **Determination of production biology of Cladocera in a reservoir receiving hyperthermal effluents from a nuclear production reactor.** Vigerstad, T.J. (Rhode Island Univ., Kingston (USA)). 1980. Contract AC09-76SR00001. 207p. NTIS, PC A10/MF A01.

The effects on zooplankton of residence in a cooling reservoir receiving hyperthermal effluents directly from a nuclear-production-reactor were examined. The design of the study was to compare rates of cladoceran population production at two stations in the winter and summer of 1976 on Par Pond, the cooling reservoir located on the Savannah River Plant, Aiken, SC. One station was located in an area of the reservoir directly receiving hyperthermal effluent (Station MAS), and the second was located about 4 km away in an area where surface temperatures were normal for reservoirs in the general geographical region (Station CAS). The statistical properties of the Edmondson egg ratio model (Edmondson, 1960) were examined to determine if it would be a suitable method for calculating cladoceran production rates for comparison between stations. Based on an examination of the variance associated with standing stock and fecundity measurements and other consideratios, the use of the egg ratio model was abandoned. Instead, a nonparametric comparison between stations of standing stock and fecundity data for Bosmina longirostris, taken for the egg ratio model, were used to observe potential hyperthermal effluent effects. There was a statistically higher incidence of deformed eggs in the Bosmina population at Station MAS in the summer. Bosmina standing stock underwent two large oscillations in the winter and three large oscillations in the summer at Station MAS compared with two in the winter and one in the summer at Station CAS. These results are consistent with almost all other Par Pond studies which have found the two stations to be essentially similar in species composition but with some statistically significant differences in various aspects of the biology of the species.

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 27736

CELLS

REFER ALSO TO CITATION(S) 27788, 27885

27912 (PNL—3300(Pt.1), pp 4-6) **Cytotoxic and mutagenic effects of diesel exhaust condensates in mammalian cell cultures.** Frazier, M.E.; Andrews, T.K. Jr.; Hooper, M.J.; Samuel, J.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Clonal growth and mutational assays using mammalian cells have been used to evaluate the cytotoxic and mutagenic potential of diesel exhaust condensates versus other fossil fuel materials. The results of these assays indicate that diesel fuel exhaust condensates are more toxic (on a microgram/ml basis) than crude oil or diesel fuel, and contain low but measurable levels of mutagenic compounds. However, these condensates are considerably less toxic than other mateials (i.e., metal chlorides) which have been tested in the clonal growth assay. Most of the mutagenic potential in these materials does not require metabolic activation.

27913 (PNL—3300(Pt.1), pp 27-29) **In vitro transformation of Syrian hamster embryo cells.** Frazier, M.E.; Andrews, T.K. Jr.; Thompson, B.B. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

A mammalian cell transformation assay is being used to evaluate the biological effects of effluents and products from various fossil fuel processes. The results of the assay, using cultured cell transformation as criteria, predict that both crude petroleum and synthetically produced fuels contain some level of potentially carcinogenic compounds. Further, while most of these compounds require metabolic activation, some direct-acting carcinogens also appear to be present.

27914 (PNL—3300(Pt.1), pp 258-259) **Cytochemical comparison of metal sulfates and chlorides in VERO cultures.** Frazier, M.E.; Andrews, T.K. Jr.; Thompson, B.B. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

A clonal growth assay was used to determine the toxicity of metallic salts in vitro. Concentrations of metallic sulfates causing decreased plating efficiency of VERO cells are similar to those previously reported for metallic chlorides. Data from these assays provides the following ranking of metal toxicity: V > Cr > Ru > Cd > Hg > Ni > Pt > Co > Pd > Zn > Cu > Mn > Pb > Fe >> Mg > Ca.

27915 (PNL—3300(Pt.1), pp 279-281) **Effect of in vitro exposure to hydrogen sulfide on cultured rabbit alveolar macrophages.** Robinson, A.V. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Cultured rabbit alveolar macrophages were exposed to 50 ppM or 200 ppM of hydrogen sulfide (H_2S). Various exposure regimens (continuous or intermittent) and various lengths of exposure were investigated. Viabiility of macrophages was measured and phagocytic ability of the cells was determined using 2-μm polyvinyltoluene beads: Exposure to H_2S inhibited phagocytosis of beads at the lowest concentration tested, 50 ppM for 20 hr. Exposure to 200 ppM for 48 hr resulted in a decrease in the number of cells containing one or more beads to as low as 2% of control values. Exposure to H_2S for 24 hr folowed by 24-hr incubation without further exposure decreased the phagocytic ability of macrophages as much as did 48 hr of continuous exposure. Viability measurements were less-sensitive indicators of cellular damage; measurement of metabolic integrity using neutral red (NR) staining was more sensitive than measurement of viability by passive permeability using trypan blue (TB) stain.

27916 **Platinum-induced mutations to 8-azaguanine resistance in Chinese hamster ovary cells.** Taylor, R.T.; Carver, J.H.; Hanna, M.L.; Wandres, D.L. (Lawrence Livermore Lab., CA). *Mutat. Res.;* **67**: 65-80(1979).

Six platinum (Pt) compounds were compared in suspension cultured Chinese hamster ovary (CHO-S) cells with respect to their inhibition of growth, their reduction of cloning efficiency, and their induction of mutants resistant to 200 μM (30 μg/ml) 8-azaguanine (8-AG) and 3 mM ouabain (OUA), respectively. The toxicity of these compounds can be ranked by the medium concentrations which decrease suspension growth/or cloning efficiency by 50%: cis-$Pt(NH_3)_2Cl_2$ (0.9/1.5 μM) > $Pt(SO_4)_2$ + methylcobalamin (MeB-12) methylation product (20/10 μM) > K_2PtCl_4 (32/50 μM) = K_2PtCl_6 (34/50 μM) = $MePtCl_3^{2-}$ (60/50 μM) > $Pt(SO_4)_2$ (66/105 μM). Following 20 h exposures to concentrations which resulted in relative survivals of 80-2%, none of the foregoing compounds increased consistently the frequency of OUA/sup R/ mutants above the spontaneous frequency (6.0×10^{-6}). Parallel treatments with 800 μM (100 μg/ml) ethyl methanesulfonate (EMS) increased the OUA/sup R/ mutant frequency 10 to 12-fold. Using 8-AG for mutant selection, dose-dependent increases 5 to 7-fold above the spontaneous frequency (3 to 8 x 10^{-5}) were obtained with cis-$Pt(NH_3)_2Cl_2$, $Pt(SO_4)_2$, and the prouct from $Pt(SO_4)_2$ + MeB-12. Identical 20 h exposures to varying amounts of K_2PtCl_4, K_2PtCl_6, and $MePtCl_3^{2-}$ did not induce 8-AG/sup R/ mutants. Optimal detection of Pt-induced 8-AG/sup R/ mutants required 7 post-treatment, expression doublings in suspension culture. Under our selection conditions 8/8 spontaneous and 24/24 Pt-induced 8-AG/sup R/ variants contained reduced hypoxanthine-guanine phosphoribosyl transferase (HGPRT) specific activities (means ranging from 3 to 11% of the parental CHO-S cells).

27917 **Platinum tetrachloride: mutagenicity and methylation with methylcobalamin.** Taylor, R.T.; Happe, J.A.; Hanna, M.L.; Wu, R. (Univ. of California, Livermore). *J. Environ. Sci. Health, Part A;* **14**: No. 2, 87-109(1979).

It was reported earlier that methylcobalamin (MeB-12) plus K_2PtCl_6 or Na_2PtCl_6 under acidic conditions yields a single square planar Pt^{2+} species, $MePtCl_3^{2-}$. A reaction between MeB-12 and PtCl, in H_2O has now been shown to occur. Complete demethylation requires two equivalents of $PtCl_4$ and $MePtCl_3^{2-}$ is the principal product. In addition, a second Me-Pt product has been detected and isolated. It has a Me/Pt ratio of 1.0, but it lacks the 260 nm

absorption maximum of $MePtCl_3^{2-}$ and it has a lower electrophoretic mobility at pH 4.5. The proton NMR spectrum of this product shows a typical triplet pattern, but the chemical shift of the center band and the spin coupling constant change with pH. Its NMR parameters suggest that this species is $MePt(H_2O)Cl_2^{1-}$ (pKa ca. 4.5). A linear bridged intermediate is proposed to account for the methylation products obtained from MeB-12 and K_2PtCl_6 (or $PtCl_4$) and the catalytic role of K_2PtCl_4. As part of a systematic study of Pt-complex mutagenesis, we also report quantitative data on the cytotoxicity and mutagenicity of $PtCl_4$ in two closely related Chinese hamster ovary lines, CHO-S and CHO-AUXB1. In CHO-S cells $PtCl_4$ induces forward mutations to 8-azaguanine resistance/hypoxanthine-guanine phosphoribosyl transferase locus (8-AG/sup R// HGPRT locus), but not to ouabain resistance (OUA/sup R/). It also induces the reversion of CHO AUXB1, a triple auxotroph. The mutagenic effects of $PtCl_4$ in both CHO lines are dose dependent in the 5-30 μM concentration range.

27918 Aryl hydrocarbon hydroxylase induction in mouse liver cells: relationship to position in the cell cycle. Becker, J.F.; Bartholomew, J.C. (Univ. of California, Berkeley). *Chem.-Biol. Interact.;* **26**: 257-266(1979).

The inducibility of aryl hydrocarbon hydroxylase (AHH) by benzo[a]pyrene (BaP) has been studied in synchronously grown cultures of mouse liver cells. These cells (NMuLi cl 8) have low basal levels of AHH which can be induced greater than 100-fold by BaP. Cells were synchronized in $G_1(G_0)$ by serum starvation and in S by release from serum starvation in combination with excess thymidine. When released from $G_1(G_0)$ by replating at lower cell density in fresh medium with 20% serum, cells began entering S with a lag of 12 h. Addition of BaP (1 μg/ml) 8 h before serum stimulation, at the time of stimulation or 7.5 h after stimulation all gave similar induction kinetics: the AHH activity peaked as the cells began entering S regardless of when the BaP was added. Cells blocked in various parts of S by excess thymidine were inducible for AHH activity as efficiently as cells moving through S and into G_2. These results indicate that the inducibility of AHH is greater when cells are actively proliferating and may be a contributing factor to why growing cells are more sensitive to mutagenesis and transformation than quiescent cells.

27919 Importance of the bay region diol-epoxide in 7,12-dimethylbenz[a]anthracene skin tumor initiation and mutagenesis. Slaga, T.J. (Oak Ridge National Lab., TN); Huberman, E.; DiGiovanni, J.; Gleason, G.; Harvey, R.G. Contract W-745-ENG-26. *Cancer Lett. (Amsterdam);* **6**: 213-220(1979).

The skin tumor-initiating and V79 mutagenic activities of various derivatives of 7,12-dimetnylbenz[a]anthracene (DMBA) were investigated to determine what possible cellular metabolite(s) may be responsible for its carcinogenicity and/or mutagenicity. 1-, 2-, 3-, 4-, and 5-hydroxyDMBA were found to be essentially inactive as skin tumor initiators whereas 9- and 10-hydroxyDMBA had weak activity. The (+-)-trans DMBA 8,9- and 5,6-dihydrodiols were also essentially inactive as skin tumor initiators and (+-)-DMBA 8β,9α-diol-10α,11α-epoxide had weak skin tumor initiating activity. All of the above tested derivatives of DMBA were essentially inactive as mutagens in the cell-mediated or direct V79 mutagenesis systems. A methyl or fluoro addition to the 1, 2, or 5 positions almost completely blocked the skin tumor initiating and V79 mutagenic activities of DMBA, whereas a fluoro addition to position 11 did not. From our data we suggest that a bay region diol-epoxide may be important in DMBA carcinogenicity and mutagenicity.

MICROORGANISMS

REFER ALSO TO CITATION(S) 27740, 27854

27920 (BNL—27848) **Effect of acidity on microbial processes in a forest soil.** Francis, A.J.; Olson, D.; Bernatsky, R. (Brookhaven National Lab., Upton, NY (USA)). Mar 1980. Contract AC02-76CH00016. 7p. (CONF-800365—5). NTIS, PC A02/MF A01.

From International conference on the ecological impact of acid precipitation; Sandefjord, Norway (11 Mar 1980).

The objective of this study is to obtain comprehensive baseline information on the microbial activity in a forest soil in order to begin an evaluation of the impact of pollutants resulting from energy related activities. Since most of the soils on Long Island, New York, are poorly buffered and may respond to acid precipitation more quickly, it was decided to study the effect of acidity on various microbial processes. A Riverhead sandy loam soil collected from an oak-pine forest with a pH of 4.6, organic matter content of 3.9%, and 0.1% total nitrogen was used in this study.

27921 (PNL—3300(Pt.1), pp 64-67) **Mutagenicity of coal liquefaction materials.** Pelroy, R.A.; Cresto, J.T.; Wilson, B.W. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

The Ames/Salmonella mutagenicity assay system was used in combination with thin layer chromatography (TLC), enzyme analysis and chemical methods to determine the most probable source of mutagenicity in the higher-molecular-weight solvent refined coal (SRC) liquefaction materials. The data obtained support the hypothesis that a single chemical class, comprised of primary aromatic amine compounds, contains the major share of the mutagenicity observed in these chemically complex mixtures.

27922 Value of chemicl fractionation for identifying the toxic components of complex aqueous effluents. Parkhurst, B.R.; Gehrs, C.W.; Rubin, I.B. (Oak Ridge National Lab., TN). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 667, 122-130(1979).

Chemical fractionation can be used to separate complex aqueous effluents into several less complex fractions, and this technique has been combined with mutagenesis testing to provide an effective means of screening the potential health hazards of products and of aqueous effluents. The purpose of this study was to evaluate the applicability of combining chemical fractionation with acute toxicity testing as a method of identifying and quantitatively assessing those components of a synthetic fuel process effluent that are toxic to aquatic biota. A representative synthetic fuel effluent was fractionated into three organic fractions (acid, base, and neutral) and an inorganic fraction. The original effluent, the fractions, and a reconsituted effluent were tested for acute toxicity to Daphnia magna. The results demonstrated that (1) the neutral fraction was the most toxic; (2) the acid and neutral fractions contributed the most toxicity, 51.3 and 41.9%, respectively, to the toxicity of the whole effluent; (3) the toxicities of the four fractions were additive; and (4) the fractionation process did not significantly alter the toxicity of the effluent. Possible applications of this approach, as well as its limitations, are discussed.

PLANTS

27923 (UCRL—83453) **Modeling the impact of SO_2 pollution on the community structure and succession in a coniferous forest of the Western USA.** Kercher, J.R.; Axelrod, M.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Apr 1980. Contract W-7405-ENG-48. 11p. (CONF-800365—1). NTIS, PC A02/MF A01.

From International conference on the ecological impact of acid precipitation; Sandefjord, Norway (11 Mar 1980).

A model is being developed to project the future impact of SO_2 pollution on western USA forests. For a case study, the model is being applied to the Ponderosa pine (Pinus ponderosa) and mixed conifer forests of the Sierra Nevada mountains of California, USA. The associated species in these forests are Abies concolor (White fir), Pseudotsuga menziesii (Douglas-fir), Pinus lambertiana (sugar pine), Libocedrus decurrens (incense-cedar), Quercus kelloggii (California black oak), and Pinus jeffreyi (Jeffrey pine). The model is based on JABOWA a simulator of forests of the northeastern USA. For use in western forests, extensive modifications are needed in JABOWA in temporal seed-crop patterns and by introducing fire ecology and moisture stress on vegetation. The model establishes individual seedlings, grows them individually, and simulates mortality of each one. A structure chart of the succession model is given. The effects of SO_2 on growth rate on Ponderosa pine, white fir, and Douglas fir are plotted.

INVERTEBRATES

REFER ALSO TO CITATION(S) 27867

27924 (UCRL—15247) **Effect of copper on Mytilus californianus and Mytilus edulis. Annual report.** (California State Univ., Hayward (USA). Dept. of Biological Sciences). 6 Jun 1980. Contract W-7405-ENG-48. 65p. NTIS, PC A04/MF A01.

Mytilus edulis and Mytilus californianus have come into widespread use as valuable test animals in estimating the effects and extent of copper pollution, both naturally as indicators and under simulated conditions as bioassays. These mussels are known bioaccumulators of heavy metals. They have a broad distribution, and mutually exclusive habitats. How the mussel reacts to copper is directly related to how copper affects the physiology of the mussel. The filtration rate and oxygen consumption of Mytilus are known to decline by more than 50% under exposure to as low as 200 ppB Cu in the water. Decline in heart rate (bradycardia) also occurs under exposure to copper. Byssus thread production suffers in copper concentrations of 500 ppB and higher. The ability of M. edulis to close its valves in the presence of copper has been documented by several researchers. Of all the physiological parameters, oxygen consumption, heart rate, and valve closure are basic physiological functions which are easily measured. Mortality of Mytilus edulis is known to occur at concentrations of copper 330 ppB and higher within four to five days. It would be advantageous to have a continuous monitoring of the heart, oxygen consumption, and valve gape during this period to determine the state of each and the

contribution of each to the possible death of the mussel. This study involves monitoring the three above physiological functions under varying concentrations of copper. In both species, M. edulis and M. californianus, detailed toxicological response records were obtained for each function. These records were then used to compare the physiological responses of each species to different levels of ambient copper in order to explain the possibility of repeatable, species-specific, response patterns to copper. (ERB)

27925 Effects of N-Nitrosopiperidine substitutions on mutagenicity in Drosophila melanogaster. Nix, C.E.; Brewen, B.; Wilkerson, R.; Lijinsky, W.; Elpler, J.L. (Oak Ridge National Lab., TN). *Mutat. Res.;* **67**: 27-38(1979).

N-Nitrosopiperidine (NP) and various derivatives were fed to Drosophila melanogaster males over a wide concentration range in order to assess their mutagenic potency in the induction of X-linked recessive lethals and chromosome loss. NP was effective in inducing lethals, as were its halogen and methylsubstituted derivatives, with the exception of 2,6-dimethyl NP. (Methyl substitutions at the alpha carbon atoms reduce or eliminate mutagenic activity.) Substitution of halogen groups on the piperidine ring enhanced the mutagenic activity, with the 3-chloro compound being the most mutagenic. In contrast, substitutions with a hydroxyl, carboxyl, or keto group resulted in a loss of mutagenicity. None of the compounds tested increased the frequency of chromosome loss or breakage in mature sperm.

27926 Effect of the physiochemical form of trace metals on their accumulation by bivalve molluscs. Harrison, F.L. (Univ. of California, Livermore). *ACS Symp. Ser.;* No. 93, 611-634(1979).

Bivalve molluscs effectively concentrate numberous elements. To maintain healthy populations of molluscs and to minimize adverse effects on man from their consumption, we must be able to predict changes in concentration after stable and radioactive nuclides are released into their environment. Both equilibrium and dynamic predictive models have been developed. Model parameters needed include concentration factors and turnover rate constants. Concentration factors and rate constants determined experimentally in the oyster Crassostrea gigas and the clam Myaarenaria differ widely with species and element. The physical form of the element in the water affects turnover also; accumulation of radionuclides of Co, Cs, Mn, and Zn is greater in water containing suspended particles. The chemical form of the element in the water affects its accumulation. When glycine, ethylenediaminetetraacetate (EDTA), yellow stuff, or clay are added to seawater, the accumulation of Cu and Zn by the oyster differs with each test material; glycine increases and EDTA decreases the accumulation of both elements. The concentrations of stable Co, Fe, Mn, and Zn in oysters and of Co, Fe, and Zn in clams fluctuate. In oysters, seasonal changes were evident. Concentrations of Co, Fe, and Zn seem to vary together, whereas that of Mn varied inversely. Before accurate predictions can be made of the accumulation of stable and radioactive nuclides of elements by bivalve molluscs, we need concentration factors, rate constants, and information on the effects of metabolic and environmental factors on these parameters for each animal species of interest.

27927 Leaky c(3)G mutant. Mckinley, C.M.; Generoso, E.E.; Grell, R.F. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Genetics;* **91**: No. 4, S79(1979).

The action of the c(3)G+ gene has been defined from the genetic behavior and ultrastructural analysis of two mutants, $c(3)G^{17}$ and $c(3)G^{68}$. These mutants eliminate meiotic recombination, increase X nondisjunction to 30 to 40%, and oocytes homozygous for either allele lack the synaptonemal complex. We report an EMS induced c(3)G allele, c(3)G/sup OR28/, which allows a low level of meiotic recombination. The c(3)G/sup OR28/, one of fifteen EMS induced c(3)G mutants studied, shows 4.3% crossing over between y^2 and f on the X chromosome and X nondisjunction of 16.7%. Recombination is strongly polarized with reductions greatest distally. X-chromosome nondisjunction in these females is highly temperature sensitive. Cold treatment (17°C) to oocytes at metaphase I-anaphase I reduces nondisjunction to 10.2%. No chromosome loss is seen at either temperature. However, in combination with the deficiency sbd^{105} which includes the c(3)G locus, no crossing over takes place and nondisjunction is high, 32%. The c(3)G/sup OR28/ does not complement with any of the fourteen other alleles. In fact, among 105 possible combinations, 47 heteroalleles have been tested and the result in all cases has been negative. Preliminary E.M. observation of the homozygous c(3)G/sup OR28/ ovary reveals that the synaptonemal complex is found occasionally but appears abnormal with disorganized central and lateral elements. The simultaneous presence of the synaptonemal complex with crossing over in c(3)G/sup OR28/ suggests that the complex may have a role in pairing and/or recombination. These data are consistant with the hypothesis of Smith and King (P.A. Smith and R.C. King, Genetics 60: 335, 1968) that c(3)G+ specifies some component of the synaptonemal complex.

VERTEBRATES

REFER ALSO TO CITATION(S) 27686, 27844, 27875, 27885, 27886, 27889, 27894, 27895, 27896, 27897, 27902, 27912, 27919, 27980

27928 (PNL—3300(Pt.1), pp 7-9) **Interactions of nickel and iron deficiency.** Ragan, H.A.; Pipes, M.J.; Klopfer, S.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Nickel fed at 250 ppM to iron-deficient rats appeared to have a sparing effect on the development of iron-deficiency anemia. Absorption of nickel was not enhanced by concurrent administration of 0.5 ppM of chlorinated water.

27929 (PNL—3300(Pt.1), pp 11-13) **Metabolism of intratracheally deposited vanadium pentoxide.** Conklin, A.W.; Skinner, C.S.; Felten, T.L.; Sanders, C.L. (Columbia Basin College, Pasco, WA). Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Vanadium pentoxide is rapidly solubilized in lung, translocated to skeleton, and excreted. Uptake of gavaged ^{48}V amounted to 2.6% of administered dose with tissue distribution similar to that with intratracheally instilled vanadium.

27930 (PNL—3300(Pt.1), pp 14) **Toxicity of nickel in the early chick embryo.** Felten, T.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Nickel caused an increase in mortality and in developmental abnormalities, particularly ocular anomalies, during early chick embryogenesis.

27931 (PNL—3300(Pt.1), pp 15) **Toxicity of cadmium chloride, oxide, and sulfate in the early chick embryo.** Felten, T.L.; Adee, R.R.; Sanders, C.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

All forms of cadmium tested resulted in approximately the same increase in mortality and in developmental abnormalities in the early chick embryo. At doses of 0.7 μg Cd or more, the Cd precipitates in a small spot in the albumin, near the yolk membrane.

27932 (PNL—3300(Pt.1), pp 16-17) **Inexpensive metabolism cage and muzzle for toxicological studies with rodents.** Skinner, C. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Efficient metabolism cages can be constructed from materials on hand in most laboratories. Combined with easily built muzzles, the units allow collection of metabolites following dermal or whole-body aerosol exposure free from oral interference.

27933 (PNL—3300(Pt.1), pp 18-21) **Cross-placental transfer and distribution of ingested lead nitrate in rats.** Hackett, P.L.; Hess, J.O.; Sikov, M.R. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Pregnant rats, at 9, 15 and 19 days of gestation, were gavaged with two dose levels of lead nitrate to determine the absorption and distribution of lead in maternal and fetal tissues. A tracer lead dose was readily absorbed (11% of the administered dose) and rapidly cleared from the gastrointestinal tract. Gastric clearance of a high lead dose was impaired, and absorption amounted to only 0.5% of the administered dose after 6 hr. Lead deposition in the fetoplacental unit was proportional to maternal absorption and directly related to age at exposure or sacrifice.

27934 (PNL—3300(Pt.1), pp 22-26) **Fetoplacental lead kinetics in rats after administration by intravenous injection, gavage, or input inhalation to a model.** Hackett, P.L.; Hess, J.O.; Sikov, M.R.; Cannon, W.C.; Blanton, E.F.; Herring, J.P.; Case, A.C. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

The deposition, distribution, and adsorption of lead in pregnant rats was compared following exposure to two dose levels by three routes of administration. Adult adsorption was found to be limited by both dose level and route of exposure. Blood lead levels in adult animals were proportional to absorption values and dictated the availability of lead to the fetoplacental unit.

27935 (PNL—3300(Pt.1), pp 30-34) **Epidermal carcinogenesis studies in mice of crude materials from several fossil fuel technologies.** Renne, R.A.; Smith, L.G.; Mahlum, D.D. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Repeated epidermal exposure to crude materials from several fossil fuel technologies induced malignant epidermal neoplasms in mice. Tumor incidence reached 100% in mice after 62 applications of 22.8 mg of the heavy distillate fraction (HD) from a solvent refined coal process (SRC II), after a maximum latency period of 147 days. Tumor incidence reached 100% in mice exposed to 0.05 mg/dose of benzo(a)pyrene, a known carcinogen, after a latency of 193 days. Tumor incidence reached 100% in 372 days in mice exposed to 2.3 mg HD/dose, and in 409 days in mice exposed to 21.2 mg/dose of crude shale oil. To date (456 days of exposure), similar tumors have been observed grossly in mice exposed to lower concentrations to these materials or the SRC II light distillate, Wilmington crude petroleum, or 2-aminoanthrancene. Futher skin-painting studies are now underway on subfractions of the most biologically active of these materials.

27936 (PNL—3300(Pt.1), pp 35-36) **Developmental toxicity of SRC II-related materials.** Andrew, F.S.; Mahlum, D.D. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Maternal and developmental toxicity potential of three SRC-II-related materials was evaluated following oral administration to pregnant rats. Dose-related developmental toxicity effects were seen, especially when exposure was from 12 to 16 days of gestation, usually at maternally toxic doses only. The SRC-II-related materials gave results very similar to materials of similar boiling-point range from SRC I.

27937 (PNL—3300(Pt.1), pp 37-38) **Developmental toxicity of SRC-I-related materials.** Andrew, F.D.; Mahlum, D.D. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

The maternal and developmental toxicity potential of three SRC-I-related materials was evaluated following oral administration to pregnant rats. Dose-related development toxicity effects were seen, specially when exposure was from 12 to 16 days of gestation, usually at maternally toxic doses only.

27938 (PNL—3300(Pt.1), pp 39-42) **Response of awake guinea pigs to inhaled histamine aerosols.** Loscutoff, S.M.; Killand, B.W.; Buschbom, R.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Guinea pigs were repeatedly exposed to histamine aerosols, while allowing progressively shorter recovery times between exposures, to determine the repeatability of the histamine response in individual animals and to assess residual effects caused by previous exposure. Repeated measurements of histamine responses in the small animal showed substantial variability, which was not significantly different from that measured in the group. Fourteen-month-old guinea pigs had significantly higher values of pulmonary compliance during initial exposure to histamine compared with all subsequent exposures. Nine-month-old guinea pigs showed no substantial differences between their initial response to histamine and responses following 12, 6 and 3 days recovery from a previous histamine exposure. Because of difficulty interpreting the dose response relationships, we propose to conduct future studies with animals exposed to a single histamine dose for a constant time interval.

27939 (PNL—3300(Pt.1), pp 43-45) **Pulmonary effects of long-term sulfuric acid aerosol exposure in normal and emphysematous guinea pigs.** Loscutoff, S.M.; Buschbom, R.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Groups of normal and elastase-treated guinea pigs (the latter had experimentally induced pulmonary emphysema) were exposed to 0, 2 and 10 mg/m^3 sulfuric acid aerosols, 6 hr/day, 5 days/wk for 16 wk. Pulmonary function measurements showed changes primarily due to elastase treatment. Acid exposure significantly increased residual volume and functional residual capacity. There appeared to be a significant interaction between acid exposure and elastase treatment, resulting in increased gas trapping in the lung. However, elastase-treated animals were not markedly more sensitive to sulfuric acid aerosols compared with normal animals.

27940 (PNL—3300(Pt.1), pp 46) **Oral toxicity of SRC II heavy distillate in the mouse.** Mahlum, D.D.; Loera, J.; Montgomery, L.D. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Charles River Swiss-Webster mice were administered one dose of SRC II heavy distillate (HD) by gavage for determination of acute toxicity. For subchronic toxicity studies, the material was administered once each day for 5 consecutive days. The animals were observed for death, and weight changes were determined. The acute LD_{50} value for mice (3.65 g/kg) was somewhat higher than that found for rats (2.98 g/kg). The subchronic LD_{50} value for mice (approximately 0.8 g/kg/day) was approximately 25% lower than that found for rats.

27941 (PNL—3300(Pt.1), pp 42-48) **Oral toxicity of solvent-refined-coal-related hydrocarbons in rats.** Mahlum, D.D.; Andrew, F.D. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Wister rats were exposed to solvent refined coal (SRC) materials or to other fossil-derived materials, including shale oil, diesel oil, and crude petroleum. Acute toxicity was determined by administering the materials one time only by gavage. Subchronic studies were performed by administering the material once daily for 5 consecutive days. The SRC-I wash solvent was the most toxic in the acute studies, having an LD_{50} of about 0.6 g/kg body weight. Toxicities of the other SRC materials were similar to one another with acute LD_{50} values of 2.3 to 3.8. Acute LD_{50} values for shale oil, diesel oil, and crude petroleum were about three- to fourfold higher, ranging from 9 to more than 12 g/kg body weight. Subchronic values for light distillate, process solvent, heavy distillate, and middle distillate were considerably lower than for the acute dose of these materials. Acute and subchronic values were similar for wash solvent and light oil. Acute LD_{50} values for process solvent and heavy distillate were substantially lower in 14-day-old rats than in adults; however, the values for 21-day-old rats (weanlings) were not greatly different from those for the adult.

27942 (PNL—3300(Pt.1), pp 49-51) **Dosimetric and metabolic studies with solvent refined coal (SRC).** Burton, F.G.; Schirmer, R.E.; Mahlum, D.D. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Tissues of rats which had received oral doses of SRC I process solvent were analyzed to determine changes in distribution of the process solvent components in the organs with time. Absorption of all the compounds from the stomach contents is slow, the rate decreasing with increasing molecular weight. Amounts of a given compound recovered from the rat also vary with the compound and with time.

27943 (PNL—3300(Pt.1), pp 52-53) **Inhalation studies with SRC I process solvent.** Springer, D.L.; Willard, D.H.; Laidler, J.R.; Mahlum, D.D. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

A system has been devised for generating aerosols of solvent refined coal process solvent (PS) with concentrations of up to 6.5 mg/l and a mass median aerodynamic diamter of $<=2.2$ μm. Exposure of adult rats ot PS for 6 hr/day for 5 days/wk for 1 to 3 wk resulted in loss of weight for a significant fraction of the animals. The weight was regained on termination on the exposure.

27944 (PNL—3300(Pt.1), pp 54-57) **Effects of SRC-related materials on ontogeny of immunocompetence in rats exposed in utero.** Graham, T.M.; Morris, J.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Maturation of the immune system was evaluated at 40 and 60 days of age in rats exposed in utero to a PCB (Arocor 1254; Ar) or to distillates from the Solvent Refined Coal-II (SRC II) process. While most of the effects of exposure were seen at both ages, the responses were more obvious by the older age. Both Ar and heavy distillate (HD) groups exhibited depressed growth of males and females. Thymus weights of the HD group were also depressed. Ar exposure markedly suppressed response of peripheral-blood lymphocytes (PBL) to both T- and B-cell mitogens and the thymus cell response to T-cell mitogens, while the response of PBL from the middle distillate group was minimally affected by both mitogen groups. These effects are consistent with a depressed immune system and/or an immature system.

27945 (PNL—3300(Pt.1), pp 58-60) **Effects of SRC-related materials on neuromuscular reflex ontogeny in rats exposed in utero.** Andrew, F.D.; Poston, K.A. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Postnatal maturation and growth was monitored in offspring of rats exposed to SRC-related materials during midgestation. Growth was depressed in some groups from birth through the end of the observation period. Effects on postnatal functional development were observed in four groups for three neurobehavioral tests.

27946 (PNL—3300(Pt.1), pp 61-63) **Application of perinatal enzyme patterns as biochemical indicators of developmental toxicity.** Andrew, F.D. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Young rats are being evaluated for signs of biochemical immaturity by assaying enzyme levels in various tissues, utilizing a small number of selected enzymes representing several metabolic pathways. Quantitative analysis of enzyme patterns in developing tissues can provide sensitive and objective criteria for tissue maturation and function comparisons. This study is attempting to demonstrate that quantification of even a small battery of enzymes in a limited group of tissues can provide a baseline for distinguishing differences in degree of developmental toxicity.

27947 (PNL—3300(Pt.1), pp 79-80) **Development of a modified rodent exposure chamber.** Cannon, W.C.; Blanton, E.F. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Studies of aerosol chamber flow patterns are suggesting ways to improve aerosol distribution in rodent exposure chambers.

27948 (PNL—3300(Pt.1), pp 81-82) **Electrical atomization of aerosols.** Clark, M.L.; Moss, O.R. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

A method of generating and characterizing aerosols by electrical atomization in conjunction with a charge spectrometer is described.

27949 (PNL—3300(Pt.1), pp 83) **Flexible-brush dust-feed mechanism.** Milliman, E.M.; Chang, D.P.Y.; Moss, O.R. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

No single commercially available device has been found capable of aerosolizing all types of finely divided solid particulate matter. A major problem area is associated with feeding bulk powder, in a uniform continuous fashion, at very low rates, to a deagglomerating device. This project involves development and testing of a novel, flexible-brush, screw-type dust-feed mechanism to achieve uniform and constant output at very low feed rates (0.5 mg/min) for extended periods (up to 2 days) of continuous or discontinuous operation without adjustment.

27950 (PNL—3300(Pt.1), pp 84-86) **Modification of a compressed-air nebulizer.** DeFord, H.; Clark, M.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

A major problem associated with using compressed-air nebulizers is the increase in concentration of the parent solution with time. This is a significant problem when associated with animal exposure studies, where the goal is to maintain a given particle size and aerosol concentration for the exposure duration.

27951 (PNL—3300(Pt.1), pp 150-151) **Toxic effects of sodium carbonate aerosols in rodents.** Busch, R.H.; McDonald, K.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Studies were conducted to establish LC_{50} concentrations of Na_2CO_3 aerosols in rats, mice, hamsters, and guinea pigs. The order of decreasing species sensitivity appears to be guinea pigs, mice, rats, and hamsters, with an LC_{50} of 750, 1900, 1600, and >8130 $\mu g/l$ concentrations, respectively, for 2-hr exposures.

27952 (PNL—3300(Pt.1), pp 157-160) **Pulmonary function evaluations of dogs exposed to cigarette smoke.** Loscutoff, S.M.; Buschbom, R.L.; Palmer, R.F.; Cross, F.T. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Pulmonary function evaluations were conducted on dogs exposed to cigarette smoke from 10 cigarettes per day. The most consistent effects of exposure were decreased in lung volumes.

27953 (PNL—3300(Pt.1), pp 212-213) **Mixed-chelate therapy of intratracheally deposited cadmium oxide.** Conklin, A.W.; Sanders, C.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Mixed-chelate treatment with EDTA and salicylic acid was no more effective in accelerating the removal of intratracheally instilled ^{109}CdO, or in protecting against CdO-induced mortality, than was EDTA given alone.

27954 (PNL—3300(Pt.1), pp 251-252) **Lung pellet carcinogenesis assay of shale oil in rats.** Dagle, G.E.; Burton, F.G.; McDonald, K.E.; McShane, J.F.; Smith, L.G.; Stevens, D.L. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Beeswax pellets impregnated with crude shale oil or its fractions were implanted into the lungs of rats for carcinogenesis studies. Pellets containing the polynuclear aromatic fraction (PNA) were the most carcinogenic, followed by those containing the basic and neutral fraction pellets. There was no difference in effects of crude shale oil and Wilmington crude petroleum.

27955 (PNL—3300(Pt.1), pp 254-255) **Late effects following exposure to graded doses of HNO_3, HCl, and H_2SO_4.** Ballou, J.E.; Gies, R.A.; Dagle, G.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Osteosarcomas of the skeleton were tentatively identified in rats exposed to HNO_3, HCl, and H_2SO_4 aerosols, and in control rats exposed to water vapor. The preliminary diagnosis is based on examination of radiographs obtained at necropsy. The tumor incidence apparently represents the spontaneous rate for male Wistar rats under our experimental conditions.

27956 (PNL—3300(Pt.1), pp 256-257) **Percutaneous penetration of ^{14}C-benzo(a)pyrene in the mouse.** Gelman, R.A.; Skinner, C.; Smith, V.H. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

About 70% of a dermally applied dose of ^{14}C-benzo(a)pyrene was absorbed in 48 hr. Tissue concentrations peaked between 3 and 6 hr after application. Absorption was not linearly related to dose as the dose increased from 12.5 $\mu g/cm^2$ to 125 $\mu g/cm^2$. Excretion was principally via the feces.

27957 (PNL—3300(Pt.1), pp 260-262) **External ATPase of a tumorigenic mammalian cell line.** Schneider, R.P.; Andrews, T.K.; Frazier, M.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

In order to test the correlation between the presence of external ATPase and tumorigenesis, nine mammalian cell lines were screened for both activities. In seven of these, the correlation was positive; in two, it was negative. The enzyme of VERO (tumorigenic) cells, when characterized biochemically, was found to be similar to that of avian leukemia cells with regard to orientation, substrate specificity, metal activation, and inhibitor sensitivity.

27958 (PNL—3300(Pt.1), pp 275) **Acute and subacute inhalation toxicology of hydrogen sulfide and ammonia in rodents.** Renne, R.A.; McDonald, K.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Rats and guinea pigs were exposed for 7 or 22 days to hydrogen sulfide, ammonia, or a combination of the two gases. Exposure for 7 days to 220 ppM H_2S, 250 ppM NH_3, or a combination of these two gases at these concentrations, induced a mild inflammation of the respiratory tract in guinea pigs. Evaluation of data from the 22-day study is in progress.

27959 (PNL—3300(Pt.1), pp 276-278) **Reproductive toxicity testing for effects of H_2S in rats.** Andrew, F.D.; Renne, R.A.; Cannon, W.C. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Subacute inhalation exposure to 220 ppM H_2S did not induce dominant lethal effects during spermatogenesis in male rats or embryotoxicity in the progeny of female rats. Minor rib anomalies were found in some of the fetuses; it is unclear whether their etiology is related to the H_2S exposure or to the genetic background of the animal stock used.

27960 (PNL—3300(Pt.1), pp 282-283) **Effect of in vivo exposure to hydrogen sulfide on free cells obtained from lungs of rats and guinea pigs.** Robinson, A.V.; McDonald, K.E.; Renne, R.A. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Rats and guinea pigs were exposed to 200 ppM H_2S for 24 hr. Twenty-four hours following cessation of exposure, the lungs of these animals were lavaged and the number, type, and viability of lavaged cells ascertained. The phagocytic capability of lavaged cells was assessed using 2-μm polyvinyltoluene beads. The number of cells obtained increased by approximately 475% in exposed rats and about 21% in exposed guinea pigs compared with unexposed controls. Distribution of cell types in rats revealed a 1600% increase in PMNs, a 57% decrease in lymphocytes, and a 50% decrease in macrophages. Corresponding values for the guinea pig revealed a 190% increase in PMNs, a 62% decrease in lymphocytes, and a 16% decrease in macrophages. Phagocytic ability was decreased by 26% for rats and 6% for guinea pigs. Cellular viability as measured by trypan blue and neutral red staining was not different from controls; however, a 13% decrease in the viability of lavaged cells in exposed rats was measured by neutral red staining.

27961 **Transplacental movements of inorganic lead from mother to fetus .** Kelman, B.J.; Walter, B.K. (Comparative Animal Research Lab., Oak Ridge, TN). Contract EY-76-C-05-0242. *Proc. Soc. Exp. Biol. Med.;* **163**: No. 2, 278-282(Feb 1980).

Placental transport of lead in the guinea pig was measured by perfusing the fetal circulation of placentas (at 60 days of gestation) in situ. The clearance of lead from mother to fetus was linearly related to umbilical flow rate and measured 0.047 +- 0.004 ml/min at an umbilical flow rate of 2.5 ml/min. Our data indicate that lead crosses the placenta from the maternal circulation to the fetal circulation at a lower clearance rate than either cadmium or methylmercury but at a greater rate than inorganic mercury.

27962 **Hypomagnesemia and insulin in cows overwintered on stockpiled fescue pasture or changed abruptly from stored feed to lush spring pasture.** Ramsey, N. (Univ. of Tennessee, Knoxville); Miller, J.K.; Bell, M.C. *Tenn. Farm Home Sci., Prog. Rep.;* 16(Oct 1979).

The purpose of this study was to investigate possible involvement of elevated blood insulin in development of low blood magnesium in grazing cows under two systems of management.

27963 **Influence of calcitonin on the initial uptake of lead and mercury by bone .** Norimatsu, H.; Talmage, R.V. (Univ. of North Carolina, Chapel Hill). Contract EY-76-S-05-4106. *Proc. Soc. Exp. Biol. Med.;* **161**: No. 1, 94-98(May 1979).

Lead acetate (20 to 40 mg/kg body weight) or mercuric chloride (3 mg/kg body weight) was injected intravenously into normal rats and those pretreated with calcitonin (0.1 mU/g body wt/hr for 1 to 4 hr). Rats were sacrificed at intervals from 5 min to 24 hr after heavy metal infection. Tibias were prepared histologically, using Okada and Mimura's vital staining technique. The metaphyses and diaphyses were examined under the light microscope to study the effect of calcitonin on the uptake and distribution of these two metals in bone. Calcitonin dramatically reduced the initial uptake of lead and mercury by bone. This reduction, at least for lead, occurred in both trabecular and compact bone. The mechanism(s) by which calcitonin influences the distribution of lead and mercury in bone has not yet been determined.

27964 **Metabolism of selenium in skeletal muscle and liver of mice with genetic muscular dystrophy.** Revis, N.W.; Horton, C.Y.; Curtis, S. (Oak Ridge National Lab., TN). *Proc. Soc. Exp. Biol. Med.;* **160**: No. 2, 139-143(Feb 1979).

The specific activity of glutathione peroxidase and the concentration of selenium in muscles from mice with genetic muscular dystrophy were both significantly increased over those of control mice. Following pretreatment with sodium selenite (10 μg/100 g body wt) for 3 days, the specific activity of glutathione peroxidase and the concentration of selenium in muscle from the dystrophic mice were both significantly increased over values in muscle from control mice. When the dystrophic and control mice were fed a diet deficient in selenium, both the activity of glutathione peroxidase and the selenium concentration were significantly decreased in muscle from both groups. However, the magnitude of decrease was significantly greater in the muscle from the control mice than in the muscle from the dystrophic mice. These results suggest that muscle from dystrophic mice has a greater capacity for selenium absorption and retention than does muscle from control mice.

27965 **Metabolism of selenium in skeletal muscle and liver of mice with genetic muscular dystrophy.** Revis, N.W.; Horton, C.Y.; Curtis, S. (Univ. of Tennessee, Oak Ridge). Contract W-7405-ENG-26. *Proc. Soc. Exp. Biol. Med.;* **160**: 139-143(1979).

Genetic muscular dystrophy is characterized by progressive muscular weakness and atrophy and necrosis of the skeletal muscle. In several aspects, the disease in genetically dystrophic mice is thought to resemble that in human beings. For a variety of species, dietary selenium deficiency can result in a state of nutritional muscular dystrophy which resembles the symptoms of inherited muscular dystrophy. However, nutritional muscular dystrophy has not been observed in animals given adequate vitamin E regardless of selenium status. Furthermore, it has been shown that genetic muscular dystrophy cannot be reversed by the addition of selenium to the diet. Several investigators have shown that glutathione peroxidase (glutathione:hydrogenperoxidase oxidoreductase, EC 1.11.1.9) activity is increased in mice and chickens with inherited muscular dystrophy. It is well documented that this enzyme requires selenium for activity and that its activity decreases markedly in response to dietary selenium deficiency . Thus, because the glutathione peroxidase activity is increased in dystrophic muscle, the metabolic basis for muscular dystrophy does not appear to be related to selenium deficiency. This increased activity of glutathione peroxidase in dystrophic muscle suggests that both selenium and enzyme protein concentrations are increased. The elevated enzyme level in the dystrophic muscle may be explained by an alteration in the rate of selenium retention and absorption which permits selenium accumulation to abnormally high concentrations. The present studies were performed to determine if such an alteration in selenium metabolism occurs in muscle from genetically dystrophic mice.

27966 **Concentrations of Cd, Cu, Mn, Pb, and Zn in fishes in a highly organic softwater pond.** Wiener, J.G.; Giesy, J.P. Jr. (Savannah River Ecology Lab., Aiken, SC). *J. Fish. Res. Board Can.;* **36**: No. 3, 270-279(1979).

Concentrations of Cd, Pb, and three essential metals (Cu, Mn, and Zn) in stocked bluegill (Lepomis macrochirus) and eight resident species of fish were studied in an acidic, highly organic pond on the southeastern US coastal plain. Concentrations of Cu, Mn, and Zn in stocked and resident fish were apparently homeostatically controlled in liver tissue, axial musculature, and whole body. Concentrations of all metals studied in axial muscle tissue and whole body of stocked bluegill remained relatively constant after 200 d of residence in the pond. Analysis of concentration factors from pond water to whole stocked bluegill indicated that Pb in this system was less available to fish than in hardwater lakes. In contrast, Cd in the pond was as available to fish as in harder waters. Differences in relative availabilities of Cd and Pb were explained by the tendency of Pb to form complexes with naturally occurring organics. The need for metal-specific analysis of biological availability of metals in highly organic softwater systems is stressed.

27967 **Comparison of the toxicity of nickel to the developing eggs and larvae of carp (Cyprinus carpio).** Blaylock, B.G.; Frank, M.L. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Bull. Environ. Contam. Toxicol.;* **21**: 604-611(1979).

SAUTER, et al., (1976) reported that fish eggs appeared to be more resistant than fry to Cd, Cu, Cr, and Pb. However, their comparison can be questioned because the exposure times varied for the fry and the eggs. The objectives of this study were (1) to determine the toxicity of Ni to developing carp eggs and newly hatched carp larvae and (2) to compare the resistance of these two life stages to Ni toxicity.

27968 **Positive correlation between declining immune competence and early mortality associated with diethylnitrosamine carcinogenesis in aging mice.** Perkins, E.H.; Clapp, N.K.; Cacheiro, L.H.; Glover, P.L.; Klima, W.C. (Oak Ridge National Lab., TN). *Mech. Ageing Dev.;* **10**: 225-232(1979).

The effect of age (2.5, 9.5, and 17 months) at time of treatment upon diethylnitrosamine (DEN) carcinogenesis and immune competence has been assessed in female BALB/c mice. Median times of death were 193, 168, and 125 days, respectively, after termination of DEN treatment. Immune competence as a measure by both cell-mediated and humoral immune parameters immediately after DEN treatment was not significantly different among treated and age-matched non-treated control animals. In contrast, a significant age-related decline in immune competence was seen in both DEN-treated and non-treated controls, thereby demonstrating a direct and positive correlation between the natural age-related decrease in immune competence and cancer-induced advanced mortality.

27969 **In vitro electrophysiological assessment of the direct cellular toxicity of carbon monoxide.** Raybourn, M.S.; Cork, C.; Schimmerling, W.; Tobias, C.A. (Univ. of California, Berkeley). *Toxicol. Appl. Pharmacol.;* **46**: 769-779(1978).

The spontaneous electrical activity of roller-tube cultured cerebellar Purkinje cells of rats was monitored to assess the relative effects of gas- and liquid-phase hyposic and/or carbon monoxide insults. It was shown that both hyposia and CO insults directly affect functional cellular activity. A tentative dose-response function was determined for gas-phase CO, in which threshold effects were seen at concentrations of 500 to 1000 ppM. Severe disruptions of electrical activity were alsways seen with CO concentrations of 5000 ppM or greater. In certain cases, CO appeared to have a cellular toxicity

over and above that due to hyposia alone, as evidenced by direct, sequential comparisons on the same cell. The inhibitory effects of CO are partially reversed by exposure of the nerve cells to white light. This effect presumably comes from the photodisassociation of CO from iron heme groups in the cell's cytochrome system.

MAN

REFER ALSO TO CITATION(S) 27740, 27844

27970 (BNL—27859) **In vivo measurement of cadmium in an occupationally-exposed population.** Ellis, K.J.; Morgan, W.D.; Yasumura, S.; Vartsky, D.; Zanzi, I.; Cohn, S.H. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 10p. (CONF-800433—5). NTIS, PC A02/MF A01.

From 4. international conference on nuclear methods in environment and energy research; Columbia, MO, USA (14 Apr 1980).

Exposure to cadmium is recognized as a potentially serious health problem. A number of clinical abnormalities have been observed in workers occupationally exposed to cadmium. Therefore, it is essential that accurate data on body burdens be available in order to formulate dose-response relationships in man. The present Brookhaven facility for in vivo measurements of cadmium in man is described, and recent results from a field study to a cadmium production plant are reported. The cadmium content of the left kidney and concentration in the liver were measured by prompt-gamma neutron activation analysis in 82 occupationally exposed workers and 10 control subjects. Organ content ranged up to 57 mg in the kidney and up to 120 ppM in the liver for the industrial group. By contrast, the values for the control group ranged from 0.4 to 11.8 mg for the kidney and 0.7 to 7.9 ppM for the liver. The geometric means were 3.7 mg for the kidney and 2.7 ppM for the liver in the control group. When the data were analyzed to provide an estimate of the critical concentration for the kidney, a range of 300 to 400 μg/g for the renal cortex was calculated. These results are compared with the available data in the literature.

27971 (BNL—27888) **Feasibility study for the in vivo measurement of silicon and beryllium by nuclear techniques.** Ettinger, K.V.; Morgan, W.D.; Miola, U.; Vartsky, D.; Ellis, K.J.; Wielopolski, L.; Cohn, S.H. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 11p. (CONF-800433—6). NTIS, PC A02/MF A01.

From 4. international conference on nuclear methods in environment and energy research; Columbia, MO, USA (14 Apr 1980).

Experiments were performed to assess the feasibility of measuring silicon in vivo by means of the prompt neutron inelastic scattering reaction $^{28}Si(n,n'\gamma)^{28}Si$. The optimum neutron energy in terms of counts per dose delivered to a liquid tissue-equivalent phantom was found to be in the range 5 to 8 MeV. By pulsing the neutron beam and counting only in the on period it was possible to substantially reduce the background both from thermal neutron interactions in the phantom and also from the fast interfering reaction $^{31}P(n,\alpha)^{28}Al$. In final measurements with a realistic chest phantom no interferences from other prompt inelastic scattering reactions were observed. With one Ge(Li) detector of 19% relative efficiency, a detection limit of 0.6g silicon per rem was obtained. A system comprising six 25% efficient detectors would be capable of measuring normal lung silicon contents of about 0.1g. Berylliosis, a granulomatous lung disease, has been observed in persons with lung contents ranging from micrograms to tens of milligrams (a normal value is 1-2 μg).. For gamma photons between 1.665 MeV and 2.225 MeV (the beryllium and deuterium photonuclear thresholds respectively), the production of neutrons is a unique property of beryllium which might be exploited for analysis in vivo. Experiments with a Pb-filtered ^{124}Sb source and an enriched $^{10}BF_3$ counter provided data from which it was projected that a 72-detector array might yield a detection limit of 3.4 mg Be for a lung dose of 2.5 rads. Possible methods for improving this result are discussed.

27972 (CONF-800602—5) **Skin contamination survey at a coal gasifier using a luminescence detector.** Vo-Dinh, T.; Gammage, R.B. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 5p. NTIS, PC A02/MF A01.

From Symposium on instrumentation and control for fossil energy processes; Virginia Beach, VA, USA (9 Jun 1980).

Skin contamination of workers in synfuel industries may be directly detected using induced fluorescence. The method uses a luminoscope, a portable luminescence detector based upon a fiberoptics lightguide. The lightguide transmits long-wavelength ultraviolet excitation radiation to the skin area being monitored at an intensity 1/100th of the radiant flux of sunlight and conveys the induced fluorescence emission from the contaminant to the detector. The instrument is suitable for detecting trace amounts of various coal tars at the $\mu g/cm^2$ levels. Coal distillate and recycle solvents from liquefaction processes can be detected at a few nl/cm^2 levels. The results of a recent field test at a coal conversion facility are reported.

27973 (COO—4552-2) **Evaluation of carbon monoxide in blood samples from the second national Health and Nutrition Survey. Progress report, April 1, 1979-April 1, 1980.** Radford, E.P. (Pittsburgh Univ., PA (USA)). 1980. Contract AC02-77EV04552. 20p. NTIS, PC A02/MF A01.

Progress is reported on research into the epidemiology of CO. CO levels in blood have been determined from 8052 samples. Smoking histories for these subjects are becoming available. The magnitude of the impact of environmental sources distinct from smoking is being evaluated. (ACR)

27974 (ORNL/EIS—142/R1) **Levels of chemical contaminants in nonoccupationally exposed US residents.** Holleman, J.W.; Hammons, A.S. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 271p. (EPA—600/1-80-002). NTIS, PC A12/MF A01.

This report is a compilation of information on chemical contaminants found in nonoccupationally exposed US residents. Listed in tabular form for each of approximately 100 elements or compounds are: the tissue the compound was found in; the range and means or medians of concentrations found; the number of cases; the analytical methods used for detection, identification, and quantitation; the bibliographic reference; information on the source and route of entry of the contaminant into the environment and into man; epidemiological and demographical aspects; and other pertinent comments. Sources of literature used in the survey cover a 30-year period, with the bulk of the studies coming from the past 10 or 15 years. About 400 references are cited. Some substances that are not necessarily contaminants are included in the report for scientific interest and to establish baselines.

27975 (ORNL/EIS—153) **Chemical contaminants in nonoccupationally exposed US residents.** Holleman, J.W.; Ryon, M.G.; Hammons, A.S. (Oak Ridge National Lab., TN (USA); Health Effects Research Lab., Research Triangle Park, NC (USA)). May 1980. Contract W-7405-ENG-26. 150p. (EPA—600/1-80-001). NTIS, PC A07/MF A01.

The manner in which chemical contaminants found in nonoccupationally exposed US residents enter the environment and subsequently human tissues is reviewed. Approximately 100 contaminants are treated. References used in the survey cover a 30-year period, with the bulk of the studies coming from the past 10 or 15 years. Contaminants discussed include organochlorine, organophosphorus, carbamate, and miscellaneous pesticides; polychlorinated and polybrominated bi- and terphenyls; halogen compounds; asbestos; mercury, lead, zinc, cadmium, copper, manganese, molybdenum, selenium, arsenic, antimony, thallium, chromium, cobalt, nickel, vanadium, beryllium; and others. Production; use; entry into the environment; entry, metabolism, and effects in man; and description and evaluation of methods of analysis and of the validity of the data are the chief aspects treated. For the pesticides indiscriminate use is the chief means of environmental entry. Entry into man is by ingestion of particulate residues and through foods, particularly fat-containing animal products. Sources of environmental entry for the metals and other elements are burning of fossil fuels, industrial operations, dissipative uses, and natural inputs; and from these sources into man by ingestion and inhalation. Some elements are essential or beneficial at one level of concentration and toxic at another. Discussions of the status of elements from this standpoint are included where appropriate.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

REFER ALSO TO CITATION(S) 27867, 27885

27976 (PNL—3300(Pt.1), pp 70-72) **Genetic effects of electric fields: effects of large DC electric fields on mutation frequencies.** Hungate, F.P.; Causey, S.C.; Kalkwarf, D.R. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Using a parallel-plate exposure system, a substantial number of microbial and bacteriophage test systems are evaluated for their response to 500- or 750-kV/m dc fields. Several strains of E. coli were tested for forward or reverse mutation; plasmids were tested for both mutation and curing; bacteriophage was tested for reverse mutation and lysogen induction; and B. subtilis was examined for evidence of forward mutation. In none of these tests was there a significant increase in mutation frequency of exposed cells as compared to simultaneously tested controls. A consistent change in the plating efficiency of E. coli-containing plasmids conferring drug resistance could not be ascribed to mutation or to loss of the plasmids (curing), and the lowered plating efficiency is presumed to due to a transient effect on intraceullular information transfer. The repair-deficient strain of Drosophila, mei-41, showed a doubling of

the frequency of sex-linked recessive mutations following exposure of pupae to a 360-kV/m dc field, as compared to controls. These data, however, are not to be considered statistically significant. Attempts to determine if secondary oxidants produced by the field might be involved were not successful.

27977 (PNL—3300(Pt.1), pp 73) **Dosimetry of extremely low-frequency electric fields.** Kaune, W.T.; Guy, A.W. (Univ. of Washington, Seattle). Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

The electric fields at the surface and those induced inside the bodies of uniformly conducting human and animal models, and in live animals exposed to ELF electric fields will be measured. These measurements are crucial if data obtained with laboratory animals are to be used for the assessment of possible hazards to humans resulting from exposure to ELF electric fields.

27978 (PNL—3300(Pt.1), pp 74) **Frequency of sister chromatid exchanges in bone marrow cells from rats exposed to a 60-Hz electric field.** McClanahan, B.J. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

Exposure of rats to a uniform, 60-Hz electric field at an unperturbed field strength of 100 kV/m has been completed. Cytogenic evaluation of bone marrow cells is in progress.

27979 (PNL—3300(Pt.1), pp 75-76) **Lethality and mutagenicity studies of electric field effects on mammalian cells: experimental design.** Frazier, M.E. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical sciences.

A study has been initiated to measure DNA damage and/or specific gene mutation resulting from exposure of mammalian cells (in vitro) to 60-Hz electric fields. This report describes the experimental goals and methods of this project.

27980 (PNL—3300(Pt.1), pp 240-242) **Dominant lethal studies in mice exposed to magnetic fields.** Montgomery, L.D.; Mahlum, D.D.; Decker, J.R. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

An experiment was performed to evaluate the effects of exposure to magnetic fields on the production of dominant lethals in male Swiss-Webster mice by ethylmethane sulfonate (EMS). Mice were administered EMS and exposed to either a homogeneous or inhomogeneous magnetic field. After exposure, the males were assessed for dominant lethal mutations by breeding to untreated females. A dose-related response to EMS was observed; however, the breeding performance and the incidence of dominant lethal mutations of the male mice injected with EMS was not affected by exposure to a magnetic field.

27981 (PNL—3300(Pt.1), pp EDB;ERA) **Development of mice after intrauterine exposure to DC magnetic fields.** Montgomery, L.D.; Sikov, M.R.; Mahlum, D.D.; Decker, J.R. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Experiments were performed to evaluate the effects on fetal development of exposure of pregnant mice to time-varying, inhomogeneous magnetic fields. No consistent or significant differences were observed between exposed fetuses and fetuses which were sham exposed in a similar environment.

27982 (PNL—3300(Pt.1), pp 245-247) **Influence of magnetic fields on development of rainbow trout (Salmo gairdneri).** Strand, J.A.; Abernethy, C.S.; Genoway, R.G.; Skalski, J.R.;Montgomery, J.C. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

The effects of a magnetic field were assessed on development in rainbow trout eggs. Particular interest is in the immediate effects of inhibited fertilization, delayed or arrested development, and inhibition of hatching.

27983 (PNL—3300(Pt.1), pp 248) **Viscosities of biopolymers in large magnetic fields.** Kalkwarf, D.R. Feb 1980.

In Pacific Northwest Laboratory annual report for 1979 to the DOE Assistant Secretary for Environment. Part 1. Biomedical Sciences.

Viscosities of representative biopolymers in aqueous solution were found to be unaffected by magnetic fields of up to 1 T even when measured in a configuration designed to maximize interaction of the field with the flowing solutes.

27984 **Mutagenic effects of magnetic fields.** Kale, P.G.; Baum, J.W. (Brookhaven National Lab., Upton, NY). Contract EY-76-C-02-0016. *Genetics;* **91**: No. 4, S58(1979).

Homogeneous magnetic fields with intensities of 13,000 G and 37,000 G were used to induce mutations in Drosophila melanogaster males. For low intensity exposure, a Varian water cooled magnet was used and for high intensity exposure, a helium cooled HEUB magnet fabricated by the Accelerator Division of this laboratory was used. Freshly laid eggs were allowed to develop in the magnetic field for seven to ten days and the emerging adult males were sequentially mated to Basc virgins to obtain six two-day broods. For the low intensity experiment, a concurrent control was kept near the magnet where the field was negligible. In this series, five lethal mutations were obtained in 5727 treated chromosomes whereas four mutations were obtained in 5310 chromosomes in the control. For the high intensity experiment, the control was maintained in the same HEUB magnet without field. In this series, four mutations were scored in 5727 treated chromosomes whereas four mutations were obtained in 5310 chromosomes in the control. The field intensities used in these experiments did not induce significantly a higher number of mutations in any of the germ cell stages.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 27681, 27682, 27683

27985 (DOE/ET/13557—18) **Impact and compliance: OSHA Carcinogen Policy.** Meyer, A.F. Jr.; Crowder, C.; Wisniewski, S.; Russell, T.; Senn, K. (Meyer (A.F.) and Associates, Inc., McLean, VA (USA)). 26 Jun 1980. Contract AC02-79ET13557. 58p. NTIS, PC A04/MF A01.

This document provides an examination of various aspects of the Occupational Safety and Health Administration (OSHA)Carcinogen Policy. To satisfy the dimensions of the Policy's broad, general nature, a two-fold approach was taken. Throughout, the focus is on the possible effects of the Policy's implementation, but this is first approached as it generally will effect research and compliance activities across broad industry sectors, while specific impacts on DOE are addressed separately. To overview and integrate these approaches, and to provide a quick reference for further information, an outline of information is presented. General or industry-wide applications are addressed both in the Summary and Overview of the Policy (Chapters I and II) and in the discussion of the Model Standard (Chapter V). Also included is a copy of the Policy itself in the General Industry Standards and interpretations Change 10. Sections specifically addressed to the major concerns of DOE and its contractors are a discussion of implications for action regarding the synthetic fuels program, a comparison of the OSHA Model Regulations and the FE OSH Manual Standards for Carcinogens, and finally, a list of known carcinogens in coal gasification/liquefaction. Together, these elements illustrate the broad scope of the policy's impact, which economic and other constraining consequences begin to become visible. Measures to minimize these consequences are a common underlying theme to each of the sections.

27986 (DOE/ET/13557—20) **Report on SARS backfit evaluation, Exxon Donor Solvent Plant, Baytown, Texas.** Meyer, A.F. Jr. (Meyer (A.F.) and Associates, Inc., McLean, VA (USA)). 2 Jul 1980. Contract AC02-79ET13557. 22p. NTIS, PC A02/MF A01.

This report provides information on observations, findings, and conclusions arising from a site visit to the Exxon Donor Solvent Plant, Baytown, Texas. That visit was to provide technical assistance and professional services to the DOE/ASFE/OPTA Project Officer regarding verification of his initial determination that this pilot plant is exempt from the SARS backfit requirement (DOE Order 5481.1). A secondary purpose was to obtain further information regarding the occupational safety and health plans and procedures at this new pilot plant facility. It is concluded that a well planned and implemented occupational safety and health program exists at the Exxon Donor Solvent Plant. Excellent manuals regarding general safety requirements and protection against carcinogens have been prepared and distributed. A Safe Operations Committee is in effect as is a Risk Management Committee. Adequate safety and industrial hygiene staff has been assigned and an excellent medical surveillance program has been established. Adequate compliance with environmental codes, standards, and regulations is being achieved. Although this plant is not subject to SARS because of the nature of the contract, adequate documentation exists in any case to exempt it from the SARS backfit requirement.

27987 (LBL—10827) **Using fire tests for quantitative risk analysis.** Ling, W.C.T.; Williamson, R.B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 41p. (CONF-800632—1). NTIS, PC A03/MF A01.

From ASTM symposium on using fire tests for quantitative risk assessment; Hilton Head, SC, USA (4 Jun 1980).

Fires can be considered a causal chain-of-events in which the growth and spread of fire may cause damage and injury if it is rapid enough to overcome the barriers placed in its way. Fire tests for fire resistance of the barriers can be used in a quantitative risk assessment. The fire growth and spread is modelled in a State Transition Model (STM). The fire barriers are presented as part of the Fire Protection Model (FPM) which is based on a portion of the NFPA Decision Tree. An Emergency Equivalent Network is introduced to couple the Fire Growth Model (FGM) and the FPM so that the spread of fire beyond the room-of-origin can be computed. An example is presented in which a specific building floor plan is analyzed to obtain the shortest expected time for fire to spread between two points. To obtain the probability and time for each link in the network, data from the results of fire tests were used. These results were found to be lacking and new standards giving better data are advocated.

27988 (ORAU—167) **Preliminary list of radiological emergency response training available to first-on-the-scene personnel.** Thompson, C. (Oak Ridge Associated Universities, Inc., TN (USA)). Jun 1980. Contract AC05-76OR00033. 19p. NTIS, PC A02/MF A01.

This study was conducted to identify the breadth of courses being supported by DOE, its contractors and other Federal and state agencies. A coordinated list of program offerings, with descriptions of each, is presented. The list can be viewed as a loose indicator of the status of training first-on-the-scene personnel.

27989 (ORNL/EIS—158) **Proceedings of the EPA workshop on the environmental scoring of chemicals.** Ross, R.H.; Welch, J. (comps.). (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 41p. (EPA—560/11-80-010). NTIS, PC A03/MF A01.

The environmental scoring of chemicals is viewed by the US Environmental Protection Agency as a tool to assist in the ranking or ordering of the universe of chemicals that are under the jurisdiction of the Toxic Substances Control Act. The purpose of scoring is to identify most of the chemicals that have a high probability for requiring review for regulation or testing. This report describes a three-day workshop held in Washington, DC, August 13 to 15, 1979, to develop an environmental scoring system. Initial discussions centered on the determination of a safety factor (calculated as the concentration at which an effect is observed divided by environmental concentration) that would allow a numerical score to be assigned to a chemical to reflect its potential hazard. Further discussion, however, indicated that the environmental concentration of a chemical is usually not available and that the estimation of an environmental concentration is not readily accomplished; therefore, a scoring system was developed that does not require environmental concentrations. This system relates environmental exposure to toxicity by using a multiplier (3x, 2x, or 1x) which is assigned on the basis of the concentration xt which an effect is observed. The applicability of the scoring system is demonstrated by scoring selected chemicals.

27990 (PUB—3000) **Health and safety manual.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1980. Contract W-7405-ENG-48. 329p. NTIS, PC A15/MF A01.

The manual consists of the following chapters: general policies and administration; the Environmental Health and Safety Department; the Medical Services Department: biological hazards; chemical safety; confined space entry; cryogenic safety; electrical safety; emergency plans; engineering and construction; evacuations, trenching, and shoring; fire safety; gases, flammable and compressed; guarding, mechanical; ladders and scaffolds, work surfaces; laser safety; materials handling and storage; noise; personal protective equipment; pressure safety; radiation safety, ionizing and non-ionizing; sanitation; seismic safety; training, environmental health and safety; tools, power and hand-operated; traffic and transportation; and warning signs and devices. (JGB)

27991 (SAND—80-1061) **Special Projects Division. Quarterly report of progress, 1 January-31 March 1980.** (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 20p. NTIS, PC A02/MF A01.

Draft versions of 5 of about 18 planned guidelines documents, designed to facilitate implementation of Environment, Safety, and Health (ES and H) Assurance programs, were completed this quarter. The conceptual design of the ES and H Assurance Program Information System was essentially completed this quarter. Some of the subtasks completed were: (1) the development of a method for classifying risk factors associated with a given hazard, (2) the development of a method of classifying known controls for addressing risk factors, and (3) the initial design of the computer output format for portraying the risk factors and their controls for a given hazard. Methodology has been tested in each of these areas. Exposure of the ES and H community to Sandia's Assurance program concepts has continued. In particular, Special Projects Divison personnel were asked to return to Western Electric Headquarters for a 3-day working session that would help the Industrial and Environmental Engineering Planning Staff to fully understand Sandia's approach so that they might adapt it to their needs and try it out somewhere within the Western Electric system.

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 26910, 26941, 26942, 26943, 26991, 26993, 26994, 27006, 27007, 27008

27992 (DOE/DP/00474—T1) **Geology of the U12n.02 (Midi Mist) drift, and postshot observations, Rainier Mesa, Area 12, Nevada Test Site.** Ege, J.R.; Danilchik, W.; Feazel, C.T. (Geological Survey, Denver, CO (USA)). May 1980. Contract AI08-76DP00474. 45p. NTIS, PC A03/MF A01.

Mining of the Ul2n.02 drift for the Midi Mist event started on December 31, 1965, in Rainier Mesa, Nevada Test Site, and was completed on December 30, 1966. The drift was mined along a bearing of S. 65° W. at an altitude of 1,850.2 m (6,070.2 ft) to a length of 643 m (2,109 ft). The drift lies in tunnel bed 4 and penetrates stratigraphically up the section through sub-units 4AB, 4CD, 4E, 4F, 4G, 4H, and 4J, all of Tertiary age. Two faults mapped at the surface of the mesa were identified as having cut the complex at drift level. No engineering construction or support problems greater than minor rock slabbing, ravelly ground, or water inflow along fractures were uncountered. Visual inspection showed that shot-induced effects in the rock medium at drift level extended for 237.7 m (780 ft) from the working point in the form of fractures and small shear displacements along bedding planes.

27993 (DP—1522) **Development and validation of GWHEAD, a three-dimensional groundwater head computer code.** Beckmeyer, R.R.; Root, R.W.; Routt, K.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Mar 1980. Contract AC09-76SR00001. 26p. NTIS, PC A03/MF A01.

A computer code has been developed to solve the groundwater flow equation in three dimensions. The code has finite-difference approximations solved by the strongly implicit solution procedure. Input parameters to the code include hydraulic conductivity, specific storage, porosity, accretion (recharge), and initial hydralic head. These parameters may be input as varying spatially. The hydraulic conductivity may be input as isotropic or anisotropic. The boundaries either may permit flow across them or may be impermeable. The code has been used to model leaky confined groundwater conditions and spherical flow to a continuous point sink, both of which have exact analytical solutions. The results generated by the computer code compare well with those of the analytical solutions. The code was designed to be used to model groundwater flow beneath fuel reprocessing and waste storage areas at the Savannah River Plant.

27994 (ORNL/TM—7115) **FLUOMEG: a planar finite difference mesh generator for fluid flow problems with parallel boundaries.** Kleinstreuer, C.; Patterson, M.R. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 63p. NTIS, PC A04/MF A01.

A two- or three-dimensional finite difference mesh generator capable of discretizing subrectangular flow regions (planar coordinates) with arbitrarily shaped bottom contours (vertical dimension) was developed. This economical, interactive computer code, written in FORTRAN IV and employing DISSPLA software together with graphics terminal, generates first a planar rectangular grid of variable element density according to the geometry and local kinematic flow patterns of a given fluid flow problem. Then subrectangular areas are deleted to produce canals, tributaries, bays, and the like. For three-dimensional problems, arbitrary bathymetric profiles (river beds, channel cross section, ocean shoreline profiles, etc.) are approximated with grid lines forming steps of variable spacing. Furthermore, the code works as a preprocessor numbering the discrete elements and the nodal points. Prescribed values for the principal variables can be automatically assigned to solid as well as kinematic boundaries. Cabinet drawings aid in visualizing the complete flow domain. Input data requirements are necessary only to specify the spacing between grid lines, determine land regions that have to be excluded, and to identify boundary nodes. 15 figures, 2 tables.

27995 (RHO-SA—164) **Prediction of infiltration and drainage using field and laboratory measured hydraulic parameters.** Jones, T.L.; Sisson, J.B.; Lu, A.H.; Jordan, W.A. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). May 1980. Contract AC06-77RL01030. 20p. (CONF-800556—2). NTIS, PC A02/MF A01.

From Annual spring meeting of the American Geophysical Union; Toronto, Ontario, Canada (22 May 1980).

Field and laboratory tests were conducted to estimate soil hydraulic conductivity and desorption parameters. Significant differences were found between field and laboratory desorption curves while certain laboratory procedures produced estimates of hydraulic conductivity comparable to field values. Differences in the desorption curves may be due to hysteresis. The field and laboratory estimates were used in a numerical model to predict infiltration and drainage and the results were compared to field data. One laboratory procedure estimated the saturated conductivity higher than others and was more useful in the model. Using field estimated desorption curves resulted in predictions which agreed better with field data. These results indicate that certain laboratory procedures may provide useful hydraulic conductivity data. Differences between field and laboratory measured desorption curves may be more significant than previously thought.

27996 (USGS-PP—1110-G) **Mississippian and Pennsylvanian (Carboniferous) systems in the United States: Tennessee.** Milici, R.C.; Briggs, G.; Knox, L.M.; Sitterly, P.D.; Statler, A.T. (Tennessee Dept. of Conservation, Knoxville (USA). Div. of Geology; Tennessee Univ., Knoxville (USA); Sehorn and Kennedy, Knoxville, TN (USA); Tennessee Dept. of Conservation, Nashville (USA). Div. of Geology). 1979. 40p. GPO.

Carboniferous strata are distributed widely across Tennessee. In general, Mississippian deposits in eastern Tennessee are thick and are dominated by terrigenous clastic deposits in the Appalachian geosyncline; Mississippian deposits to the west are thin and are composed of limestone that was deposited on a carbonate platform. The geosyncline was filled, and the carbonate platform was ultimately overlapped by Upper Mississippian and Pennsylvanian terrigenous clastic deposits. Geosyncline sequences are present in several isolated areas on Valley and Ridge thrust blocks, whereas carbonate platform deposits extend from the western Valley and Ridge, beneath the Cumberland Plateau, to the western Highland Rim. Stratigraphic nomenclature reflects regional changes in stratigraphic sequences from the geosyncline to the carbonate platform. The Carboniferous strata were deposited in marine, littoral, and delta-plain environments.

GEOPHYSICS

SEISMOLOGY AND TECTONICS

27997 (UCRL—80760(Rev.1)) **Waves in a linear viscoelastic medium: asymptotic theory.** Chin, R.C.Y.; Thigpen, L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1978. Contract W-7405-ENG-48. 68p. NTIS, PC A04/MF A01.

Uniformly valid asymptotic solutions are developed for the one-dimensional wave equation in a linear viscoelastic solid. In particular, the long-time behaviors resulting from an impulse, a unit step function, and a harmonic oscillation are investigated. The asymptotic solutions illustrate the effect of the dispersive-attenuation process. Results show a small-amplitude precursor, a diffusive main wave, and a boundary layer. The precursor propagates at a speed corresponding to the instantaneous modulus and decays exponentially with distance. The main wave travels at a speed corresponding to the equilibrium modulus and spreads diffusively. The approximating equations using perturbation methods reveal that the decay of the precursor results from relaxation processes and that the diffusive behavior results from cumulative dispersion.

VOLCANOLOGY

REFER ALSO TO CITATION(S) 27686

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 26985, 26986, 26987, 26988, 26989, 26995, 26999, 27001, 27002, 27004

27998 (UCID—18638) **Microstructure of deformed graywacke sandstones.** Dengler, L.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Mar 1980. Contract W-7405-ENG-48. 289p. NTIS, PC A13/MF A01.

Microsctures in low-permeability graywacke sandstones were studied by optical and scanning electron microscopy (SEM). SEM specimens were prepared by ion-bombardment of thick polished samples. The undeformed rock contains grains in a matrix composed primarily of authigenic chlorite and kaolinite. Chlorite platelets are randomly arranged in face-to-edge relation to one another. Kaolinite occurs as pseudohexagonal crystals stacked face-to-face in pore filling books. Uniaxial-stress experiments covered a range of confining pressures from .1 to 600 MPa. Below 50 MPa confining pressure, intergranular fracturing occurs within the fault zone and near the sample's cylindrical surface. Between 100 and 300 MPa confining pressure, fault zones contain highly fractured grains, gauge and slickensides on grain surfaces. At 600 MPa, the sample contains a diffuse shear zone of highly fractured grains and no well-defined fault. In all samples, the distribution of microcracks is heterogeneous. Different clay minerals exhibit different modes of deformation. Chlorite structure responds to applied stress by compaction, reducing both pore size and volume. Chlorite platelets are plastically deformed in even the least strained samples. Kaolinite does not deform plastically in any of the samples examined. Deformation of kaolinite is restricted to toppling of the book structure. Dilatant crack growth was studied in two samples unloaded prior to failure. Uniaxially-strained samples deform primarily along grain boundaries, producing intergranular cracks and realignment of chlorite platelets. Intragranular crack density is linearly related to axial-strain, although grains are less fractured than in uniaxially-stressed samples tested at equivalent mean pressures. Cracks are rarely longer than a grain diameter. Nuclear-explosively deformed samples were recovered after the Rio Blanco gas stimulation experiment. (JGB)

27999 (UCRL—80856) **Relationships between premeability, k, porosity, eta, and formation factor, F.** Stephens, D.R.; Lin, W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Mar 1978. Contract W-7405-ENG-48. 02p. NTIS, PC A02/MF A01.

We derive some useful relationships between permeability, porosity, and formation factor, and compare our derivations with previous work, some of which is in error. The simple equation, $k = k_0F/sup\ 5/4//m^2$, is shown to be in reasonable agreement with experimental data for a number of rocks. There are some errors in the geoscience literature concerning the relationship among permeability, k, porosity, eta, and formation factor, F, for porous media. The formation factor is defined as the ratio of electrical resistivity of a saturated rock to that of an equivalent volume of saturant. These relationships are particularly important in geophysical logging, where eta and F may be measured but k must be estimated. The purpose of this paper is to derive some simple equations relating k, eta, and F, to compare these equations with previous derivations, and to apply the equations to some recent experimental data.

28000 (UCRL—83653) **Technique for studying multiple fractures produced at intermediate loading rates.** Swift, R.P.; Kusubov, A.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Apr 1980. Contract W-7405-ENG-48. 18p. (CONF-800507—6). NTIS, PC A02/MF A01.

From Rock mechanics symposium; Rolla, MO, USA (27 May 1980).

A laboratory experimental technique has been developed to study the effects of pressurizing the borehole of rock samples with tailored pulses at intermediate loading rates. The technique provides a way to identify loading conditions needed to initiate and sustain multiple fracture growth from a borehole. Controlled loading conditions are achieved by compressing fluid in a borehole with a piston engaged by a profiled cam mounted on a rotating shaft. The experimental apparatus provides sample confinement to 50 MPa pressure, borehole pressures up to 200 MPa with loading rates from 0.01 to 100 MPa/ms, and pulse durations on the order of 1 to 50 ms. Observations from tests on a dense quartz sandstone under ambient confinement of 0.1 MPa are as follows: for static loading with oil, the breakdown pressure is about 21 MPa and two fractures oriented at 180 degrees are produced; for loadings with water at rates of about 10 MPa/ms, the breakdown pressure increases to about 30 MPa and multiple fractures are created; and for loading rates between 50 to 90 MPa/ms, the breakdown pressure increases to 35 MPa and there is an increase in the number of initiated fractures. The dependence of breakdown pressure on the loading rate is attributed to the transient water-intrusion effects around the borehole.

28001 (USGS—474-309) **Statistical evaluation of physical properties in Area 12, Nevada Test Site, using the USGS/DNA Storage and Retrieval System.** Brethauer, G.E.; Magner, J.E.; Miller, D.R. (Geological Survey, Denver, CO (USA)). May 1980. Contract AI08-76DP00474. 50p. NTIS, PC A03/MF A01.

The US Geological Survey/Defense Nuclear Agency Physical-Properties Storage and Retrieval System was used to generate tables displaying the basic statistics of physical-properties data sets sorted according to geologic identification and tunnel complex in Rainier and Aqueduct Mesas. An approximate procedure to statistically evaluate the significance of geologic identifier versus physical-property average value was developed. Results of this procedure indicate that no conclusive consistent relation exists between geologic identifier and physical-properties average value.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 26937, 27010

OCEANOGRAPHY

28002 (DOE/EV—0082) **Ecological Research Division, Marine Research Program.** (Department of Energy, Washington, DC (USA). Office of Health and Environmental Research). May 1980. 90p. NTIS, PC A05/MF A01.

This report presents program summaries of the various projects sponsored during 1979 by the Marine Research Program of the Ecological Research Division. Program areas include the effects of petroleum hydrocarbons on the marine environment; a study of the baseline ecology of a proposed OTEC site near Puerto Rico; the environmental impact of offshore geothermal energy development; the movement of radionuclides through the marine environment; the environmental aspects of power plant cooling systems; and studies of the physical and biological oceangraphy of the continental shelves bordering the United States.

28003 (DOE/EV/00902—17) **Continental Shelf processes affecting the oceanography of the South Atlantic Bight.** Pietrafesa, L.J. (North Carolina State Univ., Raleigh (USA)). 14 Apr 1980. Contract EY-76-S-09-0902. 312p. NTIS, PC A14/MF A01.

Progress in studies of the physical processes affecting the oceanography of the South Atlantic Bight is reported. NCSU personnel efforts have been focused on processing and analyzing existing data sets as well as planning and preparing for the Georgia Atlantic Bight Experiment (GABEX-1). Three cruises were conducted between June 1979 and February 1980 for the temperature/pressure recording instruments (June to Oct) and for the deployment of the GABEX I and other arrays. The Onslow Bay data sets extend over four years of observations from the mid- and outer-shelf region. Each mooring cruise has been coordinated with similar mooring deployments off Savannah and off Cape Romain with hydrographic cruises and with interdisciplinary cruises following Gulf Stream filaments and involving biological, chemical and physical oceanographers. The current meter data collected in the Carolina Capes is listed. Preprints and reprints are included.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

28004 (UCRL—84561) **Anomalous isotopic composition of cosmic rays.** Woosley, S.E.; Weaver, T.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Jun 1980. Contract W-7405-ENG-48. 21p. (CONF-800728—1). NTIS, PC A02/MF A01.

From Astrophysics workshop; Santa Cruz, CA, USA (7 Jul 1980).

Recent measurements of nonsolar isotopic patterns for the elements neon and (perhaps) magnesium in cosmic rays are interpreted within current models of stellar nucleosynthesis. One possible explanation is that the stars currently responsible for cosmic-ray synthesis in the Galaxy are typically super-metal-rich by a factor of two to three. Other possibilities include the selective acceleration of certain zones or masses of supernovas or the enhancement of ^{22}Ne in the interstellar medium by mass loss from red giant stars and planetary nebulas. Measurements of critical isotopic ratios are suggested to aid in distinguishing among the various possibilities. Some of these explanations place significant constraints on the fraction of cosmic ray nuclei that must be fresh supernova debris and the masses of the supernovas involved. 1 figure, 3 tables.

STARS

REFER ALSO TO CITATION(S) 28004

28005 (UCRL—84578) **Supernova models and light curves.** Weaver, T.A.; Woosley, S.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.; California Univ., Santa Cruz (USA)). 1980. Contract W-7405-ENG-48. 19p. (CONF-800126—3). NTIS, PC A02/MF A01.

From Conference on atomic physics and spectroscopy for supernovae spectra; San Diego, CA, USA (10 Jan 1980).

The current status of our understanding of Type II supernovae is reviewed with particular emphasis on the processes responsible for the emission of electromagnetic radiation. In addition, a relatively novel evolutionary scenario that appears to lead to a Type I supernova explosion is presented.

SOLAR PHENOMENA

REFER ALSO TO CITATION(S) 28026

COSMOLOGY

28006 (DOE/ER/03069—777) **Neutrino fluctuat nec mercitur: are fossil neutrinos detectable.** De Rujula, A. (Massachusetts Inst. of Tech., Cambridge (USA). Center for Theoretical Physics). Apr 1980. Contract AC02-76ER03069. 13p. (CONF-800469—2). NTIS, PC A02/MF A01.

From 1. workshop on grand unification; Durham, NH, USA (10 Apr 1980).

A brief report is presented on the question whether light (few eV to ~ 100 eV) neutrinos left over from the big bang are detectable. The answer is perhaps. If the weak current of leptons, like those of quarks, are not diagonal in mass eigenstates, a neutrino will decay into a lighter neutrino and a monochromatic photon. The corresponding photon line may be detectable provided: neutrinos are heavy enough to participate in galaxy clustering and neutrino lifetimes are, as in some weak interaction models, short enough.

PLANETARY PHENOMENA

28007 **Ions of Jovian origin observed by Voyager 1 and 2 in interplanetary space.** Zwickl, R.D.; Krimigis, S.M.; Armstrong, T.P.; Lanzerotti, L.J. (University of California, Los Alamos Scientific Laboratory Los Alamos, NM 87545). *Geophys. Res. Lett.;* **7**: No. 6, 453-456(Jun 1980).

Burst-like and long-lived ion fluxes (E> or ≈30 keV) of Jovian origin have been observed in interplanetary space by the LECP instrument on the Voyager 1 and 2 spacecraft. Burst (few minute durtion) events are observed at distances greater than 0.6 AU (1200 R/sub j/) from Jupiter. These events are highly anisotropic and possess steep energy spectra, while long-lived (>8 hour duration) events have relatively steady fluxes at low energies, strong anisotropies that decay with time, and a variable high energy component. Both types of events usually display simultaneous onsets and sharp cutoffs for all energies, an excess of atomic number Z> or =6 particles compared to solar and interplanetary events, and particle flow directions pointed away from Jupiter along the local interplanetary magnetic field. The origin for the long-lived events appears to be inside th bow shock of the planet.

28008 **Planet Saturn: a history of observation, theory and discovery.** Alexander, A.F.O'D. New York; Dover Publications, Inc. (1962). 474p. (NP—24442). $8.00.

Observations of Saturn throughout history are presented in a chronicle based on original sources. (GHT)

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

REFER ALSO TO CITATION(S) 27553

28009 **Ab initio and Gordon—Kim intermolecular potentials for two nitrogen molecules.** Ree, F.H.; Winter, N.W. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *J. Chem. Phys.;* **73**: No. 1, 322-336(1 Jul 1980).

Both ab initio MO—LCAO—SCF and the electron-gas (or Gordon—Kim) methods have been used to compute the intermolecular potential (Phi) of N_2 molecules for seven different N_2—N_2 orientations. The ab initio calculations were carried out using a [4s3p] contracted Gaussian basis set with and without 3d polarization functions. The larger basis set provides adequate results for Phi>0.002 hartree or intermolecular separations less than 6.5—7 bohr. We use a convenient analytic expression to represent the ab initio data in terms of the intermolecular distance and three angles defining the orientations of the two N_2 molecules. The Gordon—Kim method with Rae's self-exchange correction yields Phi, which agrees reasonably well over a large repulsive range. However, a detailed comparison of the electron kinetic energy contributions shows a large difference between the ab initio and the Gordon—Kim calculations. Using the ab initio data we derive an atom—atom potential of the two N_2 molecules. Although this expression does not accurately fit the data at some orientations, its spherical average agrees with the corresponding average of the ab initio Phi remarkably well. The spherically averaged ab initio Phi is also compared with the corresponding quantities derived from experimental considerations. The approach of the ab initio Phi to the classical quadrupole—quadrupole interaction at large intermolecular separation is also discussed.

28010 **Inductively coupled plasma-atomic emission spectroscopy: prominent lines.** Winge, R.K.; Peterson, V.J.; Fassel, V.A. (Ames Lab., IA). *Appl. Spectrosc.;* **33**: No. 3, 206-219(1979).

The prominent lines of 70 elements as emitted in an inductively coupled plasma excitation source have been identified. The lines are listed alphabetically by element and numerically by wavelength. Detection limit capabilities are estimated for each spectral line.

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 27482

28011 (DOE/ER/10454—3) **Thermodynamic implications of band structure effects for rare gases on graphite.** Carlos, W.E.; Cole, M.W.; Rauber, S.; Vidali, G.; Silva-Moreira, A.F.; Codona, J.L.; Goodstein, D.L. (Pennsylvania State Univ., University Park (USA); California Inst. of Tech., Pasadena (USA)). 1980. Contract AC02-79ER10454. 9p. (CONF-800561—1). NTIS, PC A02/MF A01.

From International conference on ordering in two dimensions; Lake Geneva, WI, USA (28 May 1980).

Recent analyses of atomic beam scattering data have suggested that an anisotropic He-C pair interaction is appropriate to the problem of He on graphite. This results in considerably more corrugated equipotential surfaces than previously assumed, and correspondingly manifest band structure effects. These have been observed for He/graphite in the specific heat for temperature T > 3°K. The implications for other gases and temperatures and for the effective adatom-adatom interaction are discussed.

28012 (UCRL—84262) **Model for H^-, D^- production by hydrogen backscattering from alkali and alkali/transition-metal surfaces.** Hiskes, J.R.; Schneider, P.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.; California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 28 May 1980. Contract W-7405-ENG-48. 14p. (CONF-800455—15). NTIS, PC A02/MF A01.

From 4. international conference on plasma surface interactions in controlled fusion devices; Garmisch, F.R. Germany (21 Apr 1980).

A model for H^-, D^- production by energetic particles reflecting from metal surfaces is discussed. The model employs the energy and angular distribution data derived from the Marlowe code. The model is applied to particles incident normally upon Cs, Ni, and Cs/Ni surfaces.

28013 **Virtual-anode formation by an intense pulsed ion beam incident upon a magnetic barrier.** Robertson, S.; Wessel, F. (Physics Department, University of California, Irvine, Calfornia 92717). *Appl. Phys. Lett.;* **37**: No. 2, 151-153(15 Jul 1980).

An intense, pulsed, initially space-charge-neutral ion beam (100 kV, 1 kA, 600 nsec) has been propagated into a transversely oriented magnetic barrier. When the magnetic field is adjusted so that (rho/sub i/rho/sub e/)/sup 1/2/ very-much-less-than a < rho/sub i/, a virtual anode is formed whose potential oscillates at ~ω/sub p/i about a value near the ion accelerating potential, where a is the transverse beam dimension, ω/sub tsp/i is the ion plasma frequency, and rho/sub e/ and rho/sub i/ are the electron and ion gyroradii. This behavior is similar to that predicted by Poukey and Rostoker for virtual cathodes.

28014 **Applied-B/sub theta/ magnetically insulated ion diode.** Greenspan, M.A.; Pal, R.; Hammer, D.A.; Humphries, S. Jr. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). ES-77-S-02-4209. *Appl. Phys. Lett.;* **37**: No. 2, 248-250(15 Jul 1980).

A new magnetically insulated ion diode geometry has been developed for use on a 270-kV, 3.3-Ω, 80-ns pulse line. A proton beam is extracted at ~100 A/cm² with a divergence angle of < or ≃ 2° (full width at half angle), and focused to over 600 A/cm². Magnetic insulation is provided by a current flowing through a conductor on the axis of the diode in the same direction as the ion beam.

28015 **Temperature dependence of thermal vibrations in cubic ZnS: A comparison of anharmonic models.** Moss, B.; McMullan, R.K.; Koetzle, T.F. (School of Physics, University of Melbourne, Parkville 3052, Victoria, Australia and Chemistry Department, State University of New York at Buffalo, Buffalo, New York 14214). *J. Chem. Phys.;* **73**: No. 1, 495-508(1 Jul 1980).

Accurate integrated intensities for the Bragg reflection of neutrons from a ZnS single crystal have been measured at temperatures between 285 and 1173 K. After correction for thermal diffuse scattering and extinction effects the data were interpreted with different models that allow anharmonic contributions to the temperature factor. Both the cumulant expansion and the one-particle potential (OPP) model with quasiharmonic temperature dependence describe the data satisfactorily, although the Grueneisen parameter obtained in the OPP analysis differs greatly from the value calculated from known thermodynamic quantities. Predictions based on Matsubara's anharmonic formalism are not in accord with the behavior observed at the highest temperatures.

28016 **Experimental measurement of increased neutral beam divergence due to a transverse magnetic field.** Conrad, J.R.; Horne, S.F.; Pirkle, D.R.; Moyer, R.A.; Peranich, L.S. (Nuclear Engineering Department, University of Wisconsin, Madison, Wisconsin 53706). *J. Appl. Phys.;* **51**: No. 7, 3456-3458(Jul 1980).

The deflection and increased divergence of a neutral beam due to a magnetic field perpendicular to the gas-cell neutralizer has been measured. The hydrogen neutral beam energy was 5.0 keV. The observed neutral beam deflection and divergence were in good agreement with results obtained from solutions of a coupled set of kinetic equations for the transverse velocity distribution functions for energetic ions and neutrals in the neutralizer volume.

28017 **Production of annular electron beams by foilless diodes.** Miller, R.B.; Prestwich, K.R.; Poukey, J.W.; Shope, S.L. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **51**: No. 7, 3506-3515(Jul 1980).

A number of important aspects of the production of annular electron beams by foilless diodes are examined, both theoretically and experimentally. The theories of Ott, Antonsen, and Lovelace (OAL) and Chen and Lovelace (CL) are compared, and the CL theory is extended to include the effect of an axial gap in an approximate fashion. For the case of finite magnetic field strengths, Larmor orbits are examined and radial oscillations of the beam profile are predicted from a beam envelope analysis. Experimental results obtained with both low- and high-impedance sources have been compared with the theory, and based on such studies, the design and construction of an intense hollow beam generator are described. Experimental results obtained with the new diode compare favorably with both the analytic theory and the results of numerical simulations. The device currently produces 2-MeV electrons at beam currents of 65—70 kA.

28018 **Slow-positron apparatus for surface studies.** Lynn, K.G.; Lutz, H. (Brookhaven National Laboratory, Upton, New York 11973). DE-AC02-76CH00016. *Rev. Sci. Instrum.;* **51**: No. 7, 977-982(Jul 1980).

We describe an apparatus for producing an intense low-energy positron beam of well-defined energy by moderating the decay positrons from a radioactive source using a clean single crystal convertor with high conversion efficiency ($\epsilon \simeq 10^{-3}$). These positrons are used as a probe to study well-characterized surfaces in an ultra-high vacuum system. The magnetically focused beam can deliver a current on the order of 2 x 10^5 positrons/s to a target when a 300 mCi ^{58}Co source is used. Characteristics of the apparatus are given and possible directions for future improvements are mentioned.

28019 **Coherent excitation of ionic states by correlated collisions in a crystal lattice.** Datz, S. (Oak Ridge National Lab., TN). pp 373-386 of Coherence and correlation in atomic collisions. Kleinpoppen, H.; Williams, J.F. (eds.). New York, NY; Plenum Publishing Corp. (1980).

Ions moving through crystals at small angles with respect to atomic rows and planes undergo correlated collisions which confine their motion (channeling). Well-channeled ions collide only with conduction electrons. For ion velocities v/sub i/ >> v/sub o/ ionization is similar to electron bombardment at v/sub e/ = v/sub i/. The ion passing the atoms spaced at a distance d in the crystal rows experiences a coherent perturbation of frequency v/sub i//d and may be resonantly excited at (v/sub i//d) = ΔE/sub ij//h. This is seen in an enhanced ionization probability. The relation of this effect on the states of the penetrating ions and the crystal fields is discussed.

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 28039

28020 **Integrated infrared intensities and transition moments in SF_6.** Kim, K.; McDowell, R.S.; King, W.T. (Metcalf Research Laboratory, Brown University, Providence, Rhode Island 02912). *J. Chem. Phys.;* **73**: No. 1, 36-41(1 Jul 1980).

The integrated infrared band intensities of the fundamental vibrational modes in SF_6 have been measured by the Wilson—Wells—Penner—Weber method. The results are 1361 +- 34 km mole^{-1} for the fundamental at 948 cm^{-1}, and 74 +- 2 km mole^{-1} for the fundamental at 615 cm^{-1}. The transition moments derived from these measurements are 0.437 +- 0.005 D for the 948 cm^{-1} fundamental and 0.126 +- 0.002 D for the 615 cm^{-1} band. The transition moment was also derived from single line strengths in the 948 cm^{-1} band and found to be 0.42 +- 0.03 D, in good agreement with the value found from band intensities.

28021 **Discrete resonance CARS emission from NO_2: Its temporal and spectral properties.** McIlwain, M.E.; Hindman, J.C. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *J. Chem. Phys.;* **73**: No. 1, 68-76(1 Jul 1980).

Coherent anti-Stokes emission has been observed for resonance excitation of NO_2 within an optical pumping geometry similar to that employed for CARS spectroscopy. Spectra have been measured for excitation of NO_2 in three wavelength regions of its

absorption: 585, 564, and 542 nm. These spectra have been used to investigate the four wave process which produces this emission and to determine the ro—vibronic contributions to the absorption of NO_2 at these wavelengths. Results from pressure quenching and time dependence studies indicate that a coherent level is produced which has a relatively long lifetime. The anti-Stokes emission has the same temporal properties as the Stokes pulse. This indicates that only the first pump photon is in resonance with an electronic transition. A comparison of these results with those expected for resonance Raman and discrete resonance Raman in particular indicates that the resonance CARS process can be interpreted by theoretical and phenomenological considerations developed to describe resonance Raman.

28022 Effects of vibronic interaction and autoionization on the photoelectron spectrum of N_2O. Dehmer, P.M.; Dehmer, J.L.; Chupka, W.A. (Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *J. Chem. Phys.;* **73**: No. 1, 126-133(1 Jul 1980).

High-resolution and high-sensitivity HeI photoelectron spectra (PES) are reported for the first four valence levels of N_2O. The vibrational structure, including many new peaks, is completely assigned for the X ^{2}Pi, A $^2\Sigma^+$, and C $^2\Sigma^+$ electronic states, and in all three cases excitation of a single quantum of the bending vibration is observed. The bending mode appears as a result of vibronic coupling within and between different electronic states. The Renner—Teller splitting is resolved in the (0,1,0) band of the transition to the X ^{2}Pi state. The relative intensities of the vibrational bands in the X ^{2}Pi and A $^2\Sigma^+$ states are compared to the intensities determined from the threshold photoelectron spectra (TPES) of Frey et al. [Chem. Phys. Lett. 54, 411 (1978)]. In both states, autoionization of intermediate neutral states that are nearly degenerate with the molecular ion state to which they decay increases the relative intensities of the higher vibrational bands in the TPES. This resonant autoionization process can enhance bands selectively, and, in particular, the higher quanta of the symmetric stretch are systematically more intense in the TPES than in the HeI PES. New relative photoionization cross sections for N_2O and its fragment ions are presented which show that even weak autoionization features can have a substantial effect on the intensities in the TPES.

28023 Ab initio effective core potentials including relativistic effects. V. SCF calculations with ω—ω coupling including results for Au_2^+, TlH, PbS, and PbSe. Lee, Y.S.; Ermler, W.C.; Pitzer, K.S. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **73**: No. 1, 360-366(1 Jul 1980).

Ab initio self-consistent field calculations are reported for a series of diatomic molecules using relativistic effective core potentials (REP) and basis sets appropriate for ω—ω coupling. The molecular orbitals are expressed as linear combinations of two-component analogs of Dirac spinors. The unique feature of the present approach is the retention of the spin—orbit operator in the generation of the REP's and the propagation of its effects into the molecular wave functions in a totally consistent fashion. The nature of bonding in the molecules Au_2^+, TlH, PbSe, and PbS is discussed with consideration of the orbital energies, spectroscopic constants, and population analyses. Comparisons with recently obtained photoelectron spectra of PbSe and PbS are made. It is noted that 6p/sub 1/2/ and 6p/sub 3/2/ orbitals exhibits bonding characteristics that are different from the nonrelativistic $p\sigma$ and $p\pi$ molecular orbitals.

28024 Identification of U III and U IV lines. Berg, J.O.; Christensen, T.E.; Kidd, P.W.; Neil, G.R.; Conway, J.G. (TRW, One Space Park, Redondo Beach, California 90278). *J. Opt. Soc. Am.;* **70**: No. 6, 716-719(Jun 1980).

Spectroscopic studies have been performed at TRW in a uranium-argon plasma using a fiber optics probe. On the basis of relative intensity as a function of distance from a uranium source, the lines were divided into four groups and assigned as U I, U II, U III, and U IV. The various charge species have different spatial dependences due to their formation, ionization, and transport rates. Confirmation of these assignments came from two separate experiments. The first was a spatial scan with a mass spectrometer probe in the same machine. The second was a time-resolved experiment on a sliding spark at Lawrence Berkeley Laboratory which showed that the lines assigned as U III correlated with a lower charge species than the lines assigned as U IV.

28025 Shock-wave compression of liquid argon to 910 kbar. Ross, M.; Nellis, W.; Mitchell, A. (Univ. of California, Livermore). *Chem. Phys. Lett.;* **68**: No. 2,3, 532-535(15 Dec 1979).

New shock-wave data are presented for liquid argon in the pressure range 400 to 910 kbar, up to nearly three times liquid density. The high temperatures excite sufficient numbers of electrons to affect the pressure and permit an estimate of the conduction band gap at high densities.

28026 Generalization of one-atom detection. Hurst, G.S.; Kramer, S.D.; Payne, M.G.; Young, J.P. (Oak Ridge National Lab., TN). *IEEE Trans. Nucl. Sci.;* **NS-26**: No. 1, 133-138(Feb 1979).

Resonance ionization spectroscopy and its associated one-atom detection can now be used to detect selectively nearly all of the elements. A notation borrowed from nuclear physics is introduced to classify five basic laser schemes that are entered into the periodic table of the elements. Applications of one-atom detection have grown to include many examples in classical physics and chemistry, photophysics, and modern physics. The modern physics category includes the detection of a few atoms generated by solar neutrino interactions in large samples and other ultralow-level counting applications for environmental research and cosmochronology. 6 figures.

28027 Measurement and analysis of the ν_2 bands of $^{14}ND_3$ and $^{15}ND_3$. Jones, L.H. (Los Alamos Scientific Lab., NM). *J. Mol. Spectrosc.;* **74**: 409-422(1979).

The ν_2 fundamentals of $^{14}ND_3$ and $^{15}ND_3$ have been observed with sufficient resolution to resolve many of the individual P, Q, and R lines for both components of the inversion doublet. With the help of the observed intensity alterations assignments of many of the lines were made. A least-squares analysis was applied to determine the various vibration-rotation constants pertinent for these transitions. The ^{14}N-^{15}N isotope shift is found to be -6.2 cm^{-1}.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

REFER ALSO TO CITATION(S) 27482

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 28082

28028 (COO—2892-18) Photoionization of atoms. Progress report, 1 April 1979-30 March 1980. Samson, J.A.R.; Starace, A.F. (Nebraska Univ., Lincoln (USA)). Dec 1979. Contract AS02-76ER02892. 26p. NTIS, PC A03/MF A01.

A strong 304 A fluorescent signal from He^+ (n = 2) has been observed as a function of incident photon wavelength; strong autoionizing structure arising from $3n^+$ states are seen in the spectrum. Measurements of the ratio of photoproduced Ne^+ ions to Ne^{2+} ions indicate that further calibration of detector response is required. The dissociative photoionization of O_2 has been measured successfully as a necessary preliminary to measuring the photoionization cross section of atomic oxygen. The experimental apparatus has been built to measure the photoelectron angular distribution of atomic cesium. In order to measure rare gas photoionization cross sections to +-1% accuracy, a new gas tight window has been developed and second order lines in the laboratory light sources have been classified. A new random phase approximation (RPA) for the theoretical calculation of open- or closed-shell atom photoionization cross sections has been developed; the close-coupling approximation and the closed-shell atom RPA of Chang and Fano are limiting cases of a new set of coupled differential equations. The Rydberg energy spectrum and oscillator strengths of atomic hydrogen have been calculated for magnetic fields of order 10^8 Gauss using a basis of oblate spheroidal angle functions. Below N $\cong$ 12 an adiabatic approximation is excellent. Above n $\cong$ 12 non-adiabatic coupling terms rapidly become important, and the perturbed energy levels for n $\geqq$ 16 cross, indicating quasi-conserved dynamical symmetries. A previous calculation of the cesium 6s $\rightarrow \epsilon$ p photoionization cross section has been extended to include interchannel coupling to the 5p $\rightarrow \epsilon$ d photoionization channels; above the near threshold cross section minimum, the cross section is dominated by 5p $\rightarrow$ 5d resonance transitions.

28029 Differential cross sections for ejection of electrons from argon by protons. Rudd, M.E.; Toburen, L.H.; Stolterfoht, N. (Behlen Laboratory of Physics, University of Nebraska, Lincoln, Nebraska 68588). EY-76-C-06-1830. *At. Data Nucl. Data Tables;* **23**: No. 5, 405-442(May 1979).

Measured cross sections for ejection of electrons from argon gas by protons of 5 keV to 5 MeV energy are given as a function of the angle and energy of ejection. These doubly differential cross sections are integrated to obtain cross sections differential in either angle or energy, total electron production cross sections, and mean energies of ejection.

28030 (IS-M—276) Surface modification and its relationship to enhanced Raman scattering from adsorbates. Furtak, T.E.; Loo, B.H. (Ames Lab., IA (USA)). 1980. Contract W-7405-ENG-82. 3p. (CONF-800808—2). NTIS, PC A02/MF A01.

From 7. international conference on raman spectroscopy; Ottawa, Canada (4 Aug 1980).

Enhanced Raman scattering from adsorbed pyridine has been observed on Au treated with 1.3 ML of Ag using 514.5 nm excita-

tion, which is normally ineffective for Au. The results are explained by models of induced resonance rather than image enhancement.

28031 (LBL—8807) **Single electron attachment and stripping cross sections for relativistic heavy ions.** Crawford, H.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1979. Contract W-7405-ENG-48. 90p. NTIS, PC A03/MF A01.

Thesis.

The results of a Bevalac experiment to measure the single electron attachment and stripping cross sections for relativistic ($0.5 < \beta < 0.95$) C, Ne and Ar ions passing through thin solid targets ranging in atomic number from 4 (Be) to 79 (Au) are reported. Magnetic analysis was used to separate the single electron, N_1, and fully stripped, N_0, ion beams emerging from the targets. Separate counters measured the number of ions in each charge state. The ratios N_1/N_0 for different target thicknesses were fit to a simple growth curve to yield electron attachment and stripping cross sections. The data are compared to relativistic extrapolations of available theories. Clear evidence for two separate attachment processes, radiative and non-radiative, is found. Data are compared to a recently improved formulation for the stripping cross sections.

28032 **Volume and temperature dependence of the Raman spectrum in phase II of solid CH_4.** Medina, F.D. (Department of Physics, Northeastern University, Boston, Massachusetts 02115). *J. Chem. Phys.;* **73**: No. 1, 77-80(1 Jul 1980).

Two samples of solid CH_4 of different densities were grown. Grueneisen parameters of 2.6 and 3.1 were obtained for the librational mode and one translational mode in phase II. The former indicates an anisotropic intermolecular potential with a strong volume dependence. We conclude that the II—III phase transition involves a sudden, simultaneous tetragonal distortion of the lattice and ordering of the orientationally disordered molecules of phase II, with a slow reorientation of the ordered molecules. The librational mode of phase II does not go soft near the transition to the disordered phase I. The temperature dependence of the linewidth for this mode can be explained by a thermally activated reorientation of the ordered molecules in phase II with an activation energy of 59 cm^{-1}.

28033 **Vibrational relaxation of D_2O (ν_2).** Miljanic, S.S.; Moore, C.B. (Department of Chemistry, University of California, Berkeley California 94720). *J. Chem. Phys.;* **73**: No. 1, 226-229(1 Jul 1980).

The method of laser-excited vibrational fluorescence has been used to measure vibrational relaxation rates for the bending mode of D_2O in collisions with D_2O, D_2, HD, H_2, He, and Ar. The rate constants at 295 K are found to be (3.2 +- 0.2) x 10^{-11}, (3.6 +- 0.2) x 10^{-13}, (1.2 +- 0.1) x 10^{-12}, (3.3 +- 0.2) x 10^{-12}, (7.1 +- 0.9) x 10^{-14}, and (3.0 +- 1.2) x 10^{-14} cm^3 $molecule^{-1}$ sec^{-1}, respectively. Relaxation times have been measured for two D_2O—HDO—H_2O mixtures and relaxation probabilities, P/sub D2Oen-dashHDO/ and P/sub D2Oen-dashH2O/ were estimated to be not very different from P/sub D2Oen-dashD2O/. The temperature dependence of the relaxation was measured for pure D_2O. The rates are (1.80 +- 0.08) x 10^{-11} at 400, (2.1 +- 0.1) x 10^{-11} at 350 and (4.0 +- 0.3) x 10^{-11} cm^3 $molecule^{-1}$ sec^{-1} at 260 K. The corresponding probabilities are fit by $P(T)=C\ \exp(\epsilon/kT)$ with $\epsilon 788$=(plus-or-minus34) K and C=1.1 x 10^{-2}.

28034 **Classical model for laser-induced nonadiabatic collision processes.** Orel, A.E.; Miller, W.H. (Department of Chemistry, and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **73**: No. 1, 241-246(1 Jul 1980).

By synthesizing earlier work of Orel and Miller and of Meyer, McCurdy, and Miller, a model for describing laser-induced electronically nonadiabatic collision processes is constructed which treats all degrees of freedom: heavy particle (i.e., translation, rotation, and vibration) electronic, and photon: by classical mechanics. This then makes it relatively easy to carry out calculations to simulate such processes within a dynamically consistent framework. Application is made to the test case H+LiF→Li+HF reaction considered by Light and Altenberger-Siczek. The most interesting feature revealed by these classical calculations is maxima in the reaction probability as a function of initial translational energy at energies below the laser-free threshold. It is seen that this structure can be understood as a Franck—Condon-like effect.

28035 **Classical trajectory study of xenon atom—chlorine dimer collisions.** Brady, J.W.; Doll, J.D.; Thompson, D.L. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **73**: No. 1, 292-296(1 Jul 1980).

Classical trajectory calculations were performed for the collision of xenon atoms with van der Waals dimers of chlorine molecules. Experimental results indicate that much more energy than required for dissociation of the dimer bond is deposited in the molecular vibrations in such processes without disrupting the complex. No energy transfer to the molecular bonds was observed for the trajectory studies, but energy was transferred to van der Waals modes. No long-lived clusters were found in which the energy transfer exceeded the van der Waals well depth. The energy threshold for collision induced dissociation was found to be roughly equal to the van der Waals well depth, in contrast to the large thresholds reported for the molecular beam experiments. It is suggested that possibly the commonly accepted values for the depth of the van der Waals wells in chlorine dimers are too small.

28036 **Rotational relaxation, anharmonic shifts, and excited state absorption in CH_3CHF_2.** Kung, R.T.V.; Friedman, H.W. (Aves Everett Research Lab., MA). *J. Chem. Phys.;* **72**: 337-347(1 Jan 1980).

An intense nsec CO_2 laser pulse was used to deplete a fraction of the rotational population of CH_3CHF_2. Rotational redistribution was monitored with a cw probe laser. The measured rotational self-relaxation rate constant is ~ 1.7 X 10^{-9} cm^3/sec. The rate constants for relaxation collisions with H_2 and N_2 are 2.9 x 10^{-10} and 1.1 X 10^{-10} cm^3/sec respectively. Measurements of the instantaneous absorption of excited vibrational levels which are directly populated by the short laser, yield anharmonic shifts (2w/sub eXe/) of ~ 7.5 cm^{-1} for the 942 cm^{-1} C-F stretchmode of this molecule.

28037 **Reactive collisions of laser excited atoms.** Solarz, R.W.; Worden, E.F.; Paisner, J.A. (California Univ., Livermore). *Opt. Eng.;* **19**: No. 1, 085-093(Jan 1980).

Recent progress in the study of chemical reactions of laser pumped electronically excited atoms is presented. A brief discussion of the design of these types of experiments is given and is based largely on the constraints imposed by presently available laser systems. A new tunable laser source developed to increase the range of experiments accessible to workers in the field is also described. Several examples of recent experiments on the reactions of laser excited atoms are given. Emphasis is given to the interpretation of the experimental results with various surface model calculations. Finally, a quick consideration of the importance of laser photochemistry to near-term industrial applications is outlined.

28038 **Synchrotron radiation photoemission studies of core level excitation effects.** Williams, G.P. (Montana State Univ., Bozeman); Lapeyre, G.J.; Anderson, J.; Cerrina, F.; Dietz, R.E.; Yafet, Y.. *Surf. Sci.;* **89**: 606-614(1979).

The recent availability of intense polarized radiation tuneable over the range 20 to 150 eV enables several core levels to be excited. Several remarkable effects have recently been reported when core excitation thresholds have been reached. For example, an increase in yield of 50% was observed in GaSe at the Se 3d threshold ($h\omega = 57$ eV). A considerable increase in photoemission intensity at 6 eV binding energy has been reported by Guillot et.al. for Ni at the 3p threshold. A very careful study has been made using the CIS, CFS and EDC models of photoemission spectroscopy of core threshold effects in Ni, Pr, and GaSe. A modulation of the Ni Fermi edge emission as a function of photon energy is found which is attributed to a configuration interaction between $3p^5\ 3d^{10}\ 4s$ and $3p^6\ 3d^8\ 4s\ \epsilon f$. Similar effects occur in Pt at the 4f threshold involving the configurations $4f^{13}\ 5d^{10}\ 6s$ and $4f^{14}\ 5d^8\ 6s$. Further, the lineshapes of the Pt and Ni upper valence band CIS's resemble those obtained by electron loss (ELS) and photoabsorption, all of which can be fitted theoretically to a Fano model. Emission from levels lying well below the Fermi level often has superimposed contributions due to incoherent effects which complicate the interpretation. In cases in which core levels are excited well above threshold, the CIS technique may be used to examine final states. Of particular interest is the possible consequend determination of adsorbate site geometry. Data are presented for 2p emission from a c(2 x 2) Na overlayer on Ni(001).

28039 **Decoupled rigid bender model for the anharmonic force field of octahedral molecules.** Vernon, M. *J. Mol. Spectrosc.;* **74**: 102-123(1979).

The molecular vibrational Hamiltonian for an octahedral molecule is derived to fourth order, subject to the constraint that the bond lengths are held constant. By assuming that the force field for the bending motions is a points-on-a-sphere potential, the location of the first difference bands for the pure bending motions is calcuated; mode couplings are neglected. With these results, systematic trends in the anharmonic shifts can be predicted for the complete family of metal-hexafluorides. The effects of mode couplings and the importance of these calcuations for understanding the initial process in the multiphoton dissociation of SF_6 are briefly discussed.

28040 **Theory of electron molecule interactions: case studies.** Dube, L.J. New Haven, CT; Yale Univ. (1978). 359p. University Microfilms Order No. 78-20,135.

Thesis (Ph. D.).

A resonant theory based on the use of a local, complex adiabatic potential to describe the dynamical response of the nuclei in a compound state is presented. Advances beyond earlier work include the following: (1) a proof that the approximate theory satisfies the principle of detailed balancing; (2) the calculation of cross sections in absolute magnitude; (3) the inclusion of a direct

component in the transition amplitudes; as well as, (4) the inclusion of exchange terms in the definition of those same amplitudes. Time is also taken to give a simpler derivation of the theory, and to clarify a number of minor points.

ATOMIC AND MOLECULAR THEORY

28041 (LBL—10979) **Application of some Hartree-Fock model calculations to the analysis of atomic and free-ion optical spectra.** Hayhurst, T.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1980. Contract W-7405-ENG-48. 306p. NTIS, PC A14/MF A01.

Thesis.

Techniques for applying ab-initio calculations to the analysis of atomic spectra are investigated, along with the relationship between the semi-empirical and ab-initio forms of Slater-Condon theory. Slater-Condon theory is reviewed with a focus on the essential features that lead to the effective Hamiltonians associated with the semi-empirical form of the theory. Ab-initio spectroscopic parameters are calculated from wavefunctions obtained via self-consistent field methods, while multi-configuration Hamiltonian matrices are constructed and diagonalized with computer codes written by Robert Cowan of Los Alamos Scientific Laboratory. Group theoretical analysis demonstrates that wavefunctions more general than Slater determinants (i.e., wavefunctions with radial correlations between electrons) lead to essentially the same parameterization of effective Hamiltonians. In the spirit of this analysis, a strategy is developed for adjusting ab-initio values of the spectroscopic parameters, reproducing parameters obtained by fitting the corresponding effective Hamiltonian. Secondary parameters are used to screen the calculated (primary) spectroscopic parameters, their values determined by least squares. Extrapolations of the secondary parameters determined from analyzed spectra are attempted to correct calculations of atoms and ions without experimental levels. The adjustment strategy and extrapolations are tested on the K I sequence from K^{0+} through Fe^{7+}, fitting to experimental levels for V^{4+}, and Cr^{5+}; unobserved levels and spectra are predicted for several members of the sequence. A related problem is also discussed: energy levels of the uranium hexahalide complexes, $(UX_6)^{2-}$ for X = F, Cl, Br, and I, are fit to an effective Hamiltonian (the f^2 configuration in O/sub h/ symmetry) with corrections proposed by Brian Judd. (SPD)

28042 (SAND—80-8707) **Observation of an optical stark effect on vibrational and rotational transitions.** Rahn, L.A.; Farrow, R.L.; Koszykowski, M.L.; Mattern, P.L. (Sandia National Labs., Livermore, CA (USA)). Jun 1980. Contract AC04-76DP00789. 15p. NTIS, PC A02/MF A01.

Vibrational and rotational Raman transitions are shown to be shifted to lower frequencies in the presence of a nonresonant, high intensity optical field. Experimental results using CARS spectroscopy for hydrogen and nitrogen are presented. The magnitude of the observed shift is in agreement with a calculation which considers the coupling of the optical field to the internuclear separation via the molecular electronic polarizability. The magnitude of the shift is predicted to be proportional to the optical field intensity.

28043 **Genealogical electronic coupling procedure incorporating the Hartree—Fock interacting space and suitable for degenerate point groups. Application to excited states of BH_3.** Swope, W.C.; Schaefer, H.F. III; Yarkony, D.R. (Department of Chemistry and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **73**: No. 1, 407-415(1 Jul 1980).

The use of Clebsch—Gordan-type coupling coefficients for finite point groups is applied to the problem of constructing symmetrized N-electron wave functions (configurations) for use by the Hartree—Fock SCF and CI methods of determining electronic wave functions for molecular systems. The configurations are eigenfunctions of electronic spin operators, and transform according to a particular irreducible representation of the relevant group of spatial operations which leave the Born—Oppenheimer Hamiltonian invariant. The method proposed for constructing the configurations involves a genealogical coupling procedure. It is particularly useful for studies of molecules which belong to a group which has multiply degenerate irreducible representations. The advantage of the method is that it results in configurations which are real linear combinations of determinants of real symmetry orbitals. This procedure for constructing configurations also allows for the identification of configurations which have no matrix element of the Hamiltonian with a reference configuration. It is therefore possible to construct a Hartree—Fock interacting space of configurations which can speed the convergence of a CI wave function. The coupling method is applied to a study of the ground and two excited electronic states of BH_3 in its D/sub 3h/ geometry. The theoretical approach involved Hartree—Fock SCF calculations followed by single and double substitution CI calculations, both of which employed double-zeta plus polarization quality basis sets.

28044 **Diabatic molecular states.** Heil, T.G.; Dalgarno, A. (Harvard-Smithsonian Center for Astrophysics, Cambridge, MA). *J. Phys., B (London);* **12**: No. 18, L557-L560(1979).

Diabatic molecular states are defined and a rigorous prescription is presented for their construction.

28045 **Relativistic energy levels of Fe XXI.** Desclaux, J.P.; Cheng, K.T.; Kim, Y.K. (Centre d'Etudes Nucleaires de Grenoble, France). *J. Phys., B (London);* **12**: No. 23, 3819-3825(1979).

Energy levels of carbon-like iron, Fe XXI, with configurations $2s^22p^2$, $2s2p^3$ and $2p^4$ are calculated from the multiconfiguration Dirac-Fock method. The relativistic electron-electron interactions represented by the Breit operator are calculated with wavefunctions of definite angular symmetry instead of averaging over configurations. The Breit interaction substantially improves the agreement between theory and experiment on the fine structures of the triplet states, while the Lamb shift corrections are very important in attaining accurate transition energies between configurations. Our results on energy levels agree with experiment to within 1% for all of the eighteen levels compared, whereas corresponding nonrelativistic results are off by 10 to 30%.

FLUID PHYSICS

GENERAL FLUID DYNAMICS

REFER ALSO TO CITATION(S) 27994

28046 (LA-UR—80-75) **Computational method for free surface hydrodynamics.** Hirt, C.W.; Nichols, B.D. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 23p. (CONF-800804—9). NTIS, PC A02/MF A01.

From ASME century 2 emerging technology conference; San Francisco, CA, USA (10 Aug 1980).

There are numerous flow phenomena in pressure vessel and piping systems that involve the dynamics of free fluid surfaces. For example, fluid interfaces must be considered during the draining or filling of tanks, in the formation and collapse of vapor bubbles, and in seismically shaken vessels that are partially filled. To aid in the analysis of these types of flow phenomena, a new technique has been developed for the computation of complicated free-surface motions. This technique is based on the concept of a local average volume of fluid (VOF) and is embodied in a computer program for two-dimensional, transient fluid flow called SOLA-VOF. The basic approach used in the VOF technique is briefly described, and compared to other free-surface methods. Specific capabilities of the SOLA-VOF program are illustrated by generic examples of bubble growth and collapse, flows of immiscible fluid mixtures, and the confinement of spilled liquids.

PROPERTIES AND STRUCTURE OF FLUIDS

28047 **Perturbation theory and the thermodynamic properties of fluids. I. General theory.** Kerley, G.I. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **73**: No. 1, 469-477(1 Jul 1980).

This paper is the first of three articles describing a new approach to the perturbation theory of liquids and dense gases. The thermodynamic properties are calculated from an expansion about a hard sphere fluid reference system, in which the hard sphere diameter is chosen by a variational principle. The method differs from that of other investigators in the description of the intermolecular forces and in the calculation of corrections to first order theory. The energy of a fluid molecule is defined by a function which depends upon the local configuration of its neighbors. All terms in the expansion are given by averages of this quantity instead of the pair potential. A modified form of the λ expansion is used to derive new expressions for corrections to first order theory, and approximations for these corrections are derived using concepts from macroscopic fluctuation theory. Using these formulas, the expansion can be computed to all orders in the perturbation. The theory is developed in terms of a general set of variables and the corresponding distribution functions which describe the short range structure of fluids.

28048 **Perturbation theory and the thermodynamic properties of fluids. II. The CRIS model.** Kerley, G.I. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **73**: No. 1, 478-486(1 Jul 1980).

This paper is the second of three articles describing a hard sphere perturbation theory of liquids and dense gases. The general theory presented in the preceding paper is used to derive a model for calculating thermodynamic properties. Three approximations are made. First, we assume that each molecule is located at the center of a spherical shell formed by its neighbors. The radius of this shell varies throughout the fluid according to a distribution function which is known for hard spheres. Second, the coordination number varies along with the nearest neighbor distance in such a way that

the volume per molecule is constant and equal to the macroscopic value. Third, the potential energy of a molecule in the field of its neighbors depends only on the nearest neighbor distance and coordination number. Using this approximation, the energy of a liquid molecule can be calculated from the zero-temperature isotherm of the solid at the same nearest neighbor distance. There are no adjustable parameters in the theory. All that is needed to apply the model is the cold curve of the solid, which can be obtained from either theory or experiment.

28049 Perturbation theory and the thermodynamic properties of fluids. III. Inverse-power and 6—12 potentials. Kerley, G.I. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **73**: No. 1, 487-494(1 Jul 1980).

This paper is the last of three articles describing a hard sphere perturbation theory of liquids and dense gases. The CRIS model, derived in the preceding papers, is tested by applying it to fluids having inverse-power and 6—12 potentials. Thermodynamic properties, radial distribution functions, and the vapor—liquid coexistence curve are calculated and compared with computer simulation results. Agreement is very good.

MAGNETOHYDRODYNAMICS

28050 Nonlinear, two-dimensional magnetohydrodynamic calculations. Schnack, D.; Killeen, J. (National Magnetic Fusion Energy Computer, Center, Lawrence Livermore Laboratory, Livermore, California 94550). *J. Comput. Phys.;* **35**: No. 1, 110-145(15 Mar 1980).

A nonlinear, time-dependent, hydromagnetic model is developed. The model is based on the eight partial differential equations of resistive magnetohydrodynamics (MHD). The equations are expressed as a set of conservation laws which are written in general, orthogonal, curvilinear coordinates in two space dimensions. No assumption about the ordering of terms is made. The resulting equations are then solved by the method of finite differences on an Eulerian mesh. We develop spatial finite-difference techniques which guarantee the simultaneous conservation of the desired physical quantities throughout the course of the calculation. Conservative boundary conditions on thermodynamic quantities at a conducting boundary are derived, and special algorithms are developed for advancing the solution at a singular boundary. For the temporal differencing, we use the Alternating Direction Implicit (ADI) method. We apply our model to the difficult case of resistive instabilities. We present results relevant to the nonlinear evolution of these modes in three distinct coordinate systems. One of these cases depends on finite plasma pressure, and can be studied only with a general model such as that presented here.

SUPERFLUIDITY

28051 Computer modeling of quantum liquids and crystals. Kalos, M.H.; Whitlock, P.A.; Ceperley, D.M. (Courant Inst. of Mathematical Sciences, New York, NY). *ACS Symp. Ser.;* No. 86, 219-230(1978).

There are a number of many-body systems which exhibit quantum effects on a macroscopic scale. These include liquid and crystal states of both He-3 and He-4, the electron gas, and neutron matter which probably constitutes the interior of pulsars. In addition, nuclear matter - hypothetical extensive system of nucleons has been studied for the insight one may gain into the nature of finite nuclei. The theoretical studies of these systems have by now a long history, but are by no means concluded. In the last few years, significant advances have been made. This has come in part from the maturity of and gradual unification of many-body theory, in part from the development and application of powerful new expansion procedures, especially varieties of hypernetted-chain equations and finally to the growing power of computer simulation methods for quantum systems. This article is a review of some recent development in computational methods for extensive quantum systems, and of the relation between results so obtained to the evolution of other theoretical work.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

REFER ALSO TO CITATION(S) 27624

ELECTROMAGNETIC INTERACTIONS

28052 (SLAC—225) **Hadron production by e^+e^- annihilation at center-of-mass energies between 2.6 and 7.8 GeV.** Siegrist, J.L. (Stanford Linear Accelerator Center, CA (USA)). Oct 1979. Contract AC03-76SF00515. 170p. NTIS, PC A08/MF A01.

Results are presented on multihadron production by e^+e^- annihilation from the Mark I and Mark II detectors at SPEAR. Other than the narrow resonances psi (3095) and psi' (3684), the total hadronic cross section varies between 36.5 and 6.4 nb over the center-of-mass energy range 2.6 to 7.8 GeV with complicated structure near 4.1 GeV not completely resolved by these measurements. Evidence for scaling of inclusive momentum distributions of hadrons is presented.

WEAK INTERACTIONS

28053 (COO—881-118) **Production of heavy flavors above 10 TeV.** Gaisser, T.K.; Stanev, T.; Halzen, F. (Delaware Univ., Newark (USA); Wisconsin Univ., Madison (USA). Dept. of Physics). 1979. Contract AC02-76ER00881. 15p. (CONF-7910103—7). NTIS, PC A02/MF A01.

From Workshop on the production of new particles in super high energy collisions; Madison, WI, USA (22 Oct 1979).

Some aspects of the cosmic ray candidates for heavy flavor production at 10 to 20 TeV are very briefly reviewed. We then discuss the prospects for seeing evidence of new flavor production in hadronic interactions around 100 TeV in cosmic ray prompt muon experiments. It may be possible to see some effects by focusing on multile energetic muons with large separations in the Homestake or other very deep experiment.

STRONG BARYON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 28055

STRONG MESON-INDUCED INTERACTIONS

28054 (BNL—27915) **Search for narrow states produced in the reaction $\pi^- p \rightarrow n +$ neutrals at 13 GeV/c.** Chiang, I.H.; Johnson, R.A.; Kwan, B. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 15p. (CONF-800724—2). NTIS, PC A02/MF A01.

From 20. international conference on high energy physics; Madison, WI, USA (17 Jul 1980).

A double-arm lead-glass, lead-scintillator calorimeter system was used to search for narrow states, such as the eta/sub c/, produced in the exclusive reactions $\pi^- p \rightarrow \gamma\gamma n$, $\pi^- p \rightarrow \pi^0\gamma n$, and $\pi^- p \rightarrow \pi^0\pi^0 n$ at 13 GeV/c. We find a 90% c.l. upper limit σ.BR $<$ 260 pb for $\gamma\gamma$ states with masses from 2.2 to 4.0 GeV/c^2. Corresponding limits on narrow $\pi^0\gamma$ and $\pi^0\pi^0$ states are also given. 4 figures.

28055 Inclusive π^+ to π^- ratios and quark distributions of pions and nucleons. Eisenberg, Y.; Haber, B.; Hochman, D.; Karshon, U.; Kogan, E.; Ronat, E.E.; Shapira, A.; Yekutieli, G. (Weizmann Inst. of Science, Rehovoth (Israel)). *Phys. Lett., B;* **83**: No. 1, 127-130(23 Apr 1979).

The ratio R of inclusive π^+/π^- production at low transverse momenta is measured in $\pi^+ n$ and pn interactions at 195 GeV/c. R (1/R) in the proton (neutron) fragmentation region increases with Feynman-x and is smaller than R from π^+ fragmentation. The results agree with a quark-quark scattering model originally proposed for 'hard' processes and disagree with a modified version of the model which includes gluon scattering.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

REFER ALSO TO CITATION(S) 28076

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 28061, 28066

28056 (COO—881-120) **Photon-gluon fusion: a review.** Leveille, J.P. (Wisconsin Univ., Madison (USA). Dept. of Physics). Nov 1979. Contract AC02-76ER00881. 41p. (CONF-7910103—8). NTIS, PC A03/MF A01.

From Workshop on the production of new particles in super high energy collisions; Madison, WI, USA (22 Oct 1979).

A brief review of the photon-gluon fusion model for heavy quark (virtual) photoproduction is presented. It is compared with existing data, and some difficulties and speculations are discussed. 12 figures.

28057 Transverse momentum distributions in Drell-Yan processes. Lo, C.Y.; Sullivan, J.D. (Illinois Univ., Urbana (USA). Dept. of Physics). *Phys. Lett., B;* **86**: No. 3-4, 327-330(8 Oct 1979).

The gauge theory predictions are calculated in leading logarithmic approximation for the transverse momentum distribution of virtual photons produced via the Drell-Yan annihilation process.

The leading contributions sum to a simple exponential form in agreement with a recent conjecture of Parisi and Petronzio and in disagreement with the finding of Dokshitser, D'Yakonov and Troyan.

28058 QCD asymptotics and kinematic thresholds in deep inelastic scattering. Bitar, K. (Illinois Univ., Urbana (USA). Dept. of Physics); Johnson, P.W.; Tung, W.K. (Illinois Inst. of Tech., Chicago (USA). Dept. of Physics). *Phys. Lett., B;* **83**: No. 1, 114-118(23 Apr 1979).

The Nachtmann moments of deep inelastic scattering structure functions are required by kinematics to contain a so far neglected threshold factor which is dependent on both n and q^2. Its presence significantly affects the 'moment analysis' in the usual QCD phenomenology, and it resolves the diffculties connected with improper threshold behavior of the 'xi-scaling' analysis of structure functions.

28059 Higgs boson production in e^+e^- annihilation. Leveille, J.P. (Wisconsin Univ., Madison (USA). Dept. of Physics). Contract EY-76-C-02-0881,COO-881-86. *Phys. Lett., B;* **83**: No. 1, 123-126(23 Apr 1979).

The reaction $e^+e^- \rightarrow H\gamma$ is studied off resonance in the standard SU(2) X U(1) model. The rate depends on the square of the number of heavy fermion multiplets. The enhancement on resonance is computed with a simple dispersion model.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 28006, 28072

28060 Leptonic decays of the Ω^-. Dicus, D.A.; Letaw, J.R. (Center for Particle Theory, University of Texas, Austin, Texas 78712). *Ann. Phys. (N.Y.);* **126**: No. 1, 32-46(15 Apr 1980).

Branching ratios, widths, and lepton energy spectra are derived for the leptonic decays of the Ω^- into Ξ^0 and Ξ^*. The calculations are made by hypothesizing that higher-order multipoles in an expansion of the baryon current are zero. The axial vector coupling is determined using the bag model.

28061 Scattering cross sections of the photino and the goldstino (gravitino) on matter. Fayet, P. (California Inst. of Tech., Pasadena (USA)). Contract DE-AC-03-79ER0068. *Phys. Lett., B;* **86**: No. 3-4, 272-278(8 Oct 1979).

The photino and the goldstino (which is absorbed into the massive gravitino if supersymmetry is realized locally) can scatter on matter. The corresponding lagrangian density is given and the cross sections are computed. Those of the photino may be much larger than ordinary weak interaction cross sections. Those of the goldstino (gravitino), proportional to G/sub Newton//m/sub 3/2/^{2}, may be negligible or on the contrary relatively large, depending on the value of the gravitino mass m/sub 3/2/.

28062 Diffractive and non-diffractive psi leptoproduction in QCD. Leveille, J.P. (Wisconsin Univ., Madison (USA). Dept. of Physics); Weiler, T. (Northeastern Univ., Boston, MA (USA). Dept. of Physics). Contract EY-76-C-02-0881,COO-881-191. *Phys. Lett., B;* **86**: No. 3-4, 377-382(8 Oct 1979).

First- and second order QCD contributions are calculated for the process $\mu N \rightarrow \mu psi X$. Striking signature differences compel the identification of $O(\alpha/sub\ s/)$ QCD with diffractive and $O(\alpha/sub\ s/^2)$ QCD with non-diffractive scattering: the $O(\alpha/sub\ s/)$ cross section peaks sharply at t=O, and has large positive psi rapidity and little hadronic energy recoil; the $O(\alpha/sub\ s/^2)$ cross section has a flat t dependence, small psi rapidity and large hadronic energy recoil.

28063 $\Delta I = 1/2$ rule and violation of CP in the six-quark model. Gilman, F.J.; Wise, M.B. (Stanford Research Inst., Menlo Park, CA (USA)). Contract EY-76-C-03-0515. *Phys. Lett., B;* **83**: No. 1, 83-86(23 Apr 1979).

The consequences for K^0 decay of the six-quark model with its natural possibility of incorporating a CP violating phase, delta, are investigated when a particular mechanism to give the $\Delta I = 1/2$ rule is operative. The most important result is that the CP violation parameter epsilon' is much larger than in previous analyses, and hence the theory has predictions for $K^0 \rightarrow \pi\pi$ decay which are experimentally distinguishable from those of the superweak model.

STRONG INTERACTIONS, GENERAL

28064 (ORO—3992-385) SO(4,1) as a structure group of a fibre bundle and SO(3,2) as a relativistic spectrum-generating group. Bohm, A. (Texas Univ., Austin (USA). Center for Particle Theory). Dec 1979. Contract AS02-76ER03992. 14p. (CONF-791157—2). NTIS, PC A02/MF A01.

From Conference on group theoretical methods in physics; Zvenigorod, USSR (28 Nov 1979).

A collective model for hadrons is presented that has two aspects: the description of nonlocal objects and the construction of spectrum-generating groups in a relativistic theory. The experimental data for this model are the mass and spin spectrum of hadron towers; each tower is characterized by a system constant α. The mass formula derived is $m^2 = \lambda^2(\alpha^2 - 9/4) + \lambda^2 s(s+1)$, where $R = 1/\lambda$ is the radius of micro-de Sitter spaces. The subject is treated under the following topics: relativistic spectrum-generating SO(3,2); nonlocal objects and SO(4,1); the SO(4,1) constraint relation for the relativistic spectrum-generating SO(3,2); and generalization of the remarkable representation and generalization of the de Sitter fiber bundle - the general relativistic rotator. 1 figure, 1 table. (RWR)

28065 (ORO—3992-386) Physical picture of color confinement. Morley, P.D. (Texas Univ., Austin (USA). Center for Particle Theory). Feb 1980. Contract AS05-76ER03992. 26p. NTIS, PC A03/MF A01.

It is shown that, if the Callan-Symanzik function, $\beta(x)$, has an infrared stable zero, then a consistent picture of confinement emerges. 5 figures, 2 tables.

STRONG INTERACTIONS, BARYON NO.=0

28066 (SLAC-PUB—2464) Tests of perturbative quantum chromodynamics in photon-photon collisions. Brodsky, S.J. (Stanford Linear Accelerator Center, CA (USA)). 1979. Contract AC03-76SF00515. 20p. (CONF-7908102—3). NTIS, PC A02/MF A01.

From International conference on two-photon interactions; Lake Tahoe, CA, USA (30 Aug 1979).

The production of hadrons in the collision of two photons via the process $e^+e^- \rightarrow e^+e^-X$ can provide an ideal laboratory for testing many of the features of the photon's hadronic interactions, especially its short-distance aspects. That part of two-photon physics which is particularly relevant to tests of perturbative QCD is reviewed here. 6 figures.

STRONG INTERACTIONS, BARYON NO.=1

28067 (ORO—3992-378) Recombination model and baryon production by pp and πp collisions. Takasugi, E.; Tata, X. (Texas Univ., Austin (USA). Center for Particle Theory). Dec 1979. Contract AS05-76ER03992. 19p. NTIS, PC A02/MF A01.

The recombination model predictions for baryon production, using modified Kuti-Weisskopf structure functions, are in good agreement with the pp and πp collision data. The indistinguishability of sea quarks naturally accounts for the difference in the p and anti p spectra in the pion fragmentation region. 4 figures, 2 tables.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

REFER ALSO TO CITATION(S) 28067

28068 Relativistic study of pp reversible $d\pi^+$: forward scattering. Keister, B.D.; Kisslinger, L.S. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Physics). *Nucl. Phys., A;* **326**: No. 2-3, 445-454(10 Sep 1979).

The reaction cross section for $pp \rightarrow d\pi^+(0^\circ)$ is calculated in the energy region W/sub c.m./ <= 3.2 GeV. It is shown that, in general, kinematic considerations necessitate a fully relativistic, nonfactored treatment of the one-meson-exchange momentum loop integral and its three main ingredients: the deuteron wave function, the emission and propagation of the off-mass-shell meson and the amplitude for off-shell meson-nucleon scattering. Near Δ-resonances nonrelativistic deuteron wave functions can be used, but off-mass-shell effects must be included.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

REFER ALSO TO CITATION(S) 28078

28069 Fermion masses and hierarchy of symmetry breaking. Branco, G.C.; Nilles, H.P.; Rittenberg, V. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). DE-AC03-76SF00515. *Phys. Rev., D;* **21**: No. 12, 3417-3422(15 Jun 1980).

We suggest that the breaking of a symmetry unifying the families of fermions occurs in stages. We consider the total Lagrangian to be invariant under the group SU(2) x U(1) x G-tilde, where G-tilde is a discrete group. The Higgs potential is, however, invariant under SU(2) x U(1) x G, where $G \supset G$. In a first stage G-tilde is broken to a subgroup $H \subset G$, but H is not contained in G-tilde. The u and d quarks are naturally massless at the tree level, and we discuss how they could acquire mass through radiative corrections.

28070 **Some features of the hidden symmetry of σ models.** Zachos, C.K. (Physics Department, University of Wisconsin-Madison, Madison, Wisconsin 53706). DE-AC02-76ER00881. *Phys. Rev., D;* **21**: No. 12, 3462-3465(15 Jun 1980).

Properties of the nonlocal invariance present in the two-dimensional σ models are analyzed and their significance is discussed.

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 28063

28071 (DOE/ER/01388—444) **Technique for measuring parity nonconservation in hydrogenic atoms.** Adelberger, E.G.; Trainor, T.A.; Fortson, E.N.; Chupp, T.E.; Holmgren, D.; Iqbal, M.Z.; Swanson, H.E. (Washington Univ., Seattle (USA). Dept. of Physics). 1979. Contract AC06-76ER01388. 21p. (RLO—1388-444). NTIS, PC A02/MF A01.

A scheme for precise measuremeat of the parity mixing of the 2s/sub 1/2/ and 2p/sub 1/2/ states in hydrogen and deuterium atoms is discussed.

APPLICATIONS TO STRONG INTERACTIONS

REFER ALSO TO CITATION(S) 28064

FIELD THEORY

REFER ALSO TO CITATION(S) 28058, 28062, 28065, 28066, 28069, 28074, 28147, 28154

28072 (COO—881-117) **Hadroproduction of heavy flavors at collider energies.** Scott, D.M. (Wisconsin Univ., Madison (USA). Dept. of Physics). Nov 1979. Contract AC02-76ER00881. 25p. (CONF-7910103—6). NTIS, PC A02/MF A01.

From Workshop on the production of new particles in super high energy collisions; Madison, WI, USA (22 Oct 1979).

The possibility of detecting the top quark in hadron interactions at collider energies is investigated. The production of bound and naked t-quarks for m/sub t/ = 15 - 100 GeV, and the experimental signatures from their leptonic and semileptonic decay modes are studied. The background to any leptonic signature is expected to be severe, suggesting the requirement of simultaneous detection of hadrons.

28073 (DOE/ER/01545—273) **CP violation without elementary scalar fields.** Eichten, E.; Lane, K.; Preskill, J. (Harvard Univ., Cambridge, MA (USA). Lyman Lab. of Physics). Apr 1980. Contract AC02-76ER01545. 11p. NTIS, PC A02/MF A01.

Dynamically broken gauge theories of electroweak interactions provide a natural mechanism for generating CP violation. Even if all vacuum angles are unobservable, strong CP violation is not automatically avoided. In the absence of strong CP violation, the neutron electric dipole moment is expected to be of order 10^{-24}e cm.

28074 (ORO—3992-382) **Quantized scalar field in rotating coordiates.** Letaw, J.R.; Pfautsch, J.D. (Texas Univ., Austin (USA). Center for Particle Theory). Dec 1979. Contract AS05-76ER03992. 23p. NTIS, PC A02/MF A01.

Second quantization of the free scalar field is carried out in rotating coordinates, and the spectrum of vacuum fluctuations is calcuated for an orbiting observer by use of these coordiates. Normal mode decomposition is identical to that in Minkowski coordiates except for the definition of positive frequency modes. Unlike the uniformly accelerating observer, the orbiting observer predicts that the Minkowski vacuum will contain no particles as he would define them. The spectrum of vacuum fluctuations is composed of the usual zero-point energy plus a contribution arising from the observer's accleration. The latter is not, as with uniformly accelerated motion, thermal. The peak energy appears to be dependent only on the torsion of the observer's world line. 3 figures.

28075 (SLAC-PUB—2512) **Some physical aspects of higher twist.** Blankenbecler, R. (Stanford Univ., CA (USA)). May 1980. Contract AC03-76SF00515. 8p. (CONF-800374—3). NTIS, PC A02/MF A01.

From 15. Rencontre de Moriond; Les Arcs, France (9 Mar 1980).

A brief description of some of the physical origins of higher twist terms and their possible relevance to data is given. 13 references, 7 figures.

28076 **Gravitational effects on and of vacuum decay.** Coleman, S.; De Luccia, F. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-76SF00515. *Phys. Rev., D;* **21**: No. 12, 3305-3315(15 Jun 1980).

It is possible for a classical field theory to have two stable homogeneous ground states, only one of which is an absolute energy minimum. In the quantum version of the theory, the ground state of higher energy is a false vacuum, rendered unstable by barrier penetration. There exists a well-established semiclassical theory of the decay of such false vacuums. In this paper, we extend this theory to include the effects of gravitation. Contrary to naive expectation, these are not always negligible, and may sometimes be of critical importance, especially in the late stages of the decay process.

28077 **Influence of the self-energy diagrams on the solutions of a scalar Bethe-Salpeter equation.** Li, B.A.; Hsien, T.C.; Yan, S.; Chen, T.L.; Yang, C.Z.; Lu, J.F. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-76SF00515. *Phys. Rev., D;* **21**: No. 12, 3325-3332(15 Jun 1980).

The influence of self-energy diagrams on solutions of the Bethe-Salpeter equation is studied by taking a gphi*/ $_1$(x)phi$_1$(x)phi$_2$(x) interaction in the ladder approximation. The results show that for ground-state solutions the self-energy diagrams will diminish the eigenvalues and alter the wave functions slightly. However, for the excited states and antisymmetric solutions, the influence of the self-energy diagrams is considerable, and completely alters the properties of the solutions. Their wave functions look like a δ function and their eigenvalues are independent of the binding energy and the quantum numbers. The results also show that the infrared behavior of the self-energy diagrams is very important for the solutions of the equation, and that the solutions from the ladder approximation are meaningful only in the loosely bound cases. As the binding becomes tight, the contribution from the self-energy diagrams becomes important.

28078 **Phase structure of non-Abelian lattice gauge theories.** Rebbi, C. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973). DE-AC02-76CH00016. *Phys. Rev., D;* **21**: No. 12, 3350-3359(15 Jun 1980).

The phase structure of four-dimensional lattice gauge theories based on finite non-Abelian groups is studied by Monte Carlo computations. All models examined exhibit a two-phase structure with a first-order phase transition. In three systems where the gauge group is a discrete subgroup of SU(2) the critical temperature moves toward zero as the order of the group increases and the high-temperature phase has confining properties.

28079 **Composite-particle form factor in $(\phi^3)_6$ theory.** Chao, S.C. (Department of Physics, Columbia University, New York, New York 10027). *Phys. Rev., D;* **21**: No. 12, 3423-3427(15 Jun 1980).

The asymptotic behavior of the scalar form factor at large momentum transfer Q in asymptotically free $(\phi^3)_6$ theory is studied. The leading logarithms of the form factor are calculated. The sum of all the logarithms is proved to be a sum of exponentials. The asymptotic behavior of this process is not directly controlled by the renormalization group.

28080 **Vierbein Singularities in CP^2.** Schonfeld, J.F. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). E(11-1)-1764. *Ann. Phys. (N.Y.);* **126**: No. 1, 123-134(15 Apr 1980).

The compact open four-dimensional manifold CP^2, with Euclidean metric, has recently attracted attention as an example of a spacetime in which fields of half-integral spin cannot be defined in the absence of additional structure (such as an electromagnetic background). In this note we identify the specific topological anomaly responsible for this phenomenon: CP^2 contains a class of two-dimensional spheres-"complex lines": in small neighborhoods of each of which the two transverse degrees of freedom are forced to "twist" in a characteristic way. It is shown in detail how the twists force vierbeins: tetrads of orthonormal vector fields that play a central role in the theory of spinors: to have singularities on every complex line. As an aid to visualization we construct an example of a vierbein with, loosely speaking, the smallest possible set of singularities: It is ill-defined at every point of some one complex line and smooth everywhere else. The behavior of such a vierbein near any one of its singular points is characterized explicitly. The structure of the minimally singular vierbein is used to illuminate the observation of Hawking and Pope that in the presence of an appropriate electromagnetic background, fields of any spin can exist on CP^2 as long as their electric charges are correctly quantized, but that the charge values available to half-integral-spin fields differ from those available to integral-spin fields.

28081 **Continuum limit of QED_2 on a lattice, II.** Weingarten, D. (Physics Department, Indiana University, Bloomington, Indiana 47405). *Ann. Phys. (N.Y.);* **126**: No. 1, 154-175(15 Apr 1980).

In a preceding article a Mattews—Salam formula was constructed for the Schwinger functions (vacuum expectation values of polynomials in the fields) of Euclidean QED_2 on a periodic lattice. For any combination of gauge or fermion fields G on a lattice with

spacing proportional to N^{-1}, $N \epsilon Z^{+}$, the Matthews—Salam formula for the vacuum expectation <G>/sub N/ has the form <G>/sub N/= $\int$ dμW/sub N/(G,f), where μ is an N-independent measure on a random electromagnetic field f and W/sub N/(G,f) in an N-dependent function of f and G. In the present article we prove that the limit of $\int$ dμW/sub N/(G,f) exists as N→∞ and has the form lim/sub N/→∞ $\int$ dμW/sub N/(G,f)= $\int$ dμW(G,f), where W(G,f) is in L/sup p/(μ) for all p, ∞ >p>0.

SCATTERING THEORY

REFER ALSO TO CITATION(S) 28143

28082 Interfacing theory and experiment in polarization studies. Goldstein, G.R.; Moravcski, M.J. (Department of Physics, Tufts University, Medford, Massachusetts 02155). *Ann. Phys. (N.Y.);* **126**: No. 1, 176-197(15 Apr 1980).

The results of this paper pertain to any particle reaction in atomic, nuclear, or high-energy physics, and deal with some of the general properties of such reactions. A formalism for discussing polarization experiments in such reactions is suggested in which appropriately chosen reaction amplitudes are directly related to quantities actually measured in experiments, thus making the connections between theory and experiment as simple as possible and eliminating intermediary quantities between theory and experiment. It is proven that such direct experimental observables along two quantization directions always suffice in completely determining the amplitudes from experimental data. It is also shown that given a specific theoretical model prediction for the reaction amplitudes in any formulation, one can always find a quantization direction such that the measurement of the number of particles in one single projection state with respect to that quantization direction forms a null experiment to test the theoretical prediction. Three examples of particle reactions are worked out in detail to illustrate the problem and the suggested formalism. In the concluding section the main results are summarized and their implications are discussed with respect to the design of experiments and the interfacing of theories with experimental verification.

PHYSICS RESEARCH

NUCLEAR PHYSICS

28083 (COO—4215-3) **University of Minnesota progress report No. 4215.** Hintz, N.M. (Minnesota Univ., Minneapolis (USA)). 1979. Contract AS02-77ER04215. 70p. NTIS, PC A04/MF A01.

Medium-energy nuclear physics research at the University of Minnesota is reviewed. The following studies were undertaken: HRS development; $^{58\ 60\ 62\ 64}$Ni(p,p') at 800 MeV; proton scattering on 2s-1d-shell nuclei; search for orbit flip states in ^{90}Zr, ^{120}Sn, ^{144}Sm, and ^{208}Pb; large-angle A $^{116\ 124}$Sn, ^{208}Pb elastic scattering; proton scattering from heavy deformed nuclei; unnatural-parity states in ^{6}Li, ^{10}B, ^{12}C, ^{14}N, and ^{28}Si; microscopic form factor calculations - force studies; DEC PDP 11/60 computer; theoretical analysis computer programs; inelastic electron scattering on ^{90}Zr; and EPICS programs. Three of the above topics, with significant amounts of data, are indexed separately. 40 figures, 1 table. (RWR)

EXPERIMENTAL TECHNIQUES

28084 (DOE/ER/10496—1) **Sizes and shapes of short-lived nuclei via laser spectroscopy. Progress report, 1 August 1979-1 May 1980.** Lewis, D.A. (Iowa State Univ. of Science and Technology, Ames (USA)). May 1980. Contract AC02-79ER10496. 13p. NTIS, PC A02/MF A01.

The first stage of the program to study the sizes and shapes of short-lived nuclei through their atomic hyperfine structure is the development of a movable laser spectroscopy system. Progress in this area is described in this report along with plans for experiments at Argonne National Laboratory and Brookhaven National Laboratory. 2 figures.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 28091

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 28075

28085 Analytical theory of pion single and double charge exchange in resonance region.I. Geometrical limit. Johnson, M.B. (Los Alamos Scientific Laboratory of the University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **22**: No. 1, 192-208(Jul 1980).

We derive analytical formulas for angular distributions $\sigma(\theta)$ of pion single and double charge exchange to analog states. The result is based on the eikonal approximation and assumes that the interactions are invariant under isospin rotations. The theory reproduces semiquantitatively the results of exact coupled channel, lowest order optical model calculations and explicates the dependence of $\sigma(\theta)$ on the structure of the nuclear target. The $\sigma(\theta)$ for single charge exchange is proportional to the square of the ratio of the valence neutron density Δrho(R-bar) to the total density rho(R-bar). The theory predicts R-bar as a function of energy and mass number A; for pion kinetic energy T/sub π/ $\simeq$ 180 MeV, rho(R-bar) $\simeq$ 0.1—0.2 of central density. The $\sigma(\theta)$ for double charge exchange is proportional to [Δrho(R-bar)/rho(R-bar)]^4. The strong dependence of $\sigma(\theta)$ on Δrho/rho suggests that the single and double charge exchange reactions may develop into a sensitive probe of the neutron halo. The dependence of $\sigma(\theta)$ on the diffuseness of rho and Δrho is also evaluated. Assuming that the neutron and proton densities are proportional, the relative A dependence of $\sigma(\theta)$ for single and double charge exchange is calculated. The result is in qualitative agreement with recent measurements for single charge exchange and predicts that a similar set of measurements for double charge exchange may be feasible. Realistic densities are used to calculate the magnitude of $\sigma(\theta)$. Large enhancements are found in this case, but $\sigma(\theta)$ falls below the preliminary data by as much as a factor of 4. Difficulties in reproducing the observed angular distribution of the ^{18}O(π^{+},π^{-})^{18}Ne reaction are similar to those of other theories. The extent of discrepancy suggests the occurrence of strong modifications of the pion-nucleon interaction in the nuclear medium.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

28086 (BNL—27911) ^{18}O + ^{12}C **fusion-evaporation reaction.** Heusch, B.; Beck, C.; Coffin, J.P.; Freeman, R.M.; Gallmann, A.; Haas, F.; Rami, F.; Wagner, P.; Alburger, D.E. (Brookhaven National Lab., Upton, NY (USA); Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires). 1980. Contract AC02-76CH00016. 8p. (CONF-800488—1). NTIS, PC A02/MF A01.

From International conference on nuclear behavior at high angular momentum; Strasbourg, France (Apr 1980).

Portions of document are illegible.

A study of the ^{18}O + ^{12}C fusion evaporation reaction has been undertaken for 2 reasons: to make a systematic study of the formation cross section for each individual evaporation residue over a broad excitation energy region in the compound nucleus ^{30}Si:30 to 62 MeV; and to compare all results to fusion-evaporation calculations done in the framework of the Hauser-Feschbach statistical model.

28087 (COO—4215-3, pp 9, 47-57) **Unnatural parity states in ^{6}Li, ^{10}B, ^{12}C, ^{14}N and ^{28}Si.** 1979.

In University of Minnesota progress report No. 4215.

Energy spectra from protein inelastic scattering by ^{6}Li, ^{10}B, ^{12}C, ^{14}N, and ^{28}Si are shown, along with tentative fits to preliminary angular distributions for all but ^{28}Si, and asymmetries for ^{6}Li and ^{12}C. 11 figures. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 28087

28088 (COO—4215-3, pp 4-5, 25-29) **Proton scattering on 2s-1d shell nuclei.** 1979.

In University of Minnesota progress report No. 4215.

Results of a coupled-channels analysis of ^{24}Mg(p,p') reactions at 0.8 GeV are presented as a function of angle. Also shown are

spectra from proton scattering from ^{26}Mg, ^{32}S, and ^{28}Si, along with an angular distribution from the latter. 5 figures. (RWR)

28089 **^{30}Si(^{12}C, ^{12}C') reaction at 41.3 MeV.** Baker, F.T.; Scott, A. (Georgia Univ., Athens (USA)); Gross, E.E.; Hensley, D.C.; Hillis, D.L. (Oak Ridge National Lab., TN (USA)). *Nucl. Phys., A;* **325**: No. 2-3, 525-532(1979).

Angular distributions for the 0^+, 2^+ states of ^{30}Si have been measured for the ^{30}Si(^{12}C, ^{12}C') reaction at a lab energy of 41.3 MeV. The data have been analyzed using coupled-channels calculations incorporating three possible models for the structure of ^{30}Si - an oblate rotor, a prolate rotor and a harmonic vibrator. On the basis of the quality of the fits to the data as determined by the minimum chi^2, a prolate-rotor model is favored.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

REFER ALSO TO CITATION(S) 28085, 28096

MASS, ABUNDANCE, AND BINDING ENERGY

28090 **Systematics of nuclear charge distributions in the mass 60 region from elastic electron scattering and muonic x-ray measurements.** Wohlfahrt, H.D.; Schwentker, O.; Fricke, G.; Andresen, H.G.; Shera, E.B. (Institut fuer Kernphysik der Johannes Gutenberg-Universitaet, D-6500 Mainz, Germany). *Phys. Rev., C;* **22**: No. 1, 264-283(Jul 1980).

Precise ratios of elastic electron scattering cross sections for the nuclei /sup 54,56,58/Fe, /sup 58,60,62,64/Ni, and /sup 64,66,68,70/Zn have been measured in the momentum-transfer region 0.6 fm^{-1} < or = q < or = 2.3 fm^{-1}. The data were analyzed with a Fourier-Bessel parametrization of the charge distribution. Charge distribution differences were determined nearly model independently for the $\Delta A=2$ isotope and isotone pairs. The $\Delta Z=2$ isotone charge distribution differences show a strong shell effect. For the $\Delta N=2$ isotopes we observe a nearly constant increase of the "half density radius" in the investigated region of the 2p/sub 3/2/, 1f/sub 5/2/, and 2p/sub 1/2/ neutron shells. However, the skin thickness of the charge distribution increases strongly at the beginning (^{56}Fe-^{54}Fe) and decreases at the end (^{70}Zn-^{68}Zn) of these shells by adding two neutrons. The rms radii differences deduced from a combined analysis of the electron scattering data and present muonic x-ray data show the same trend. These differences, determined model independently with a typical accuracy of some 10^{-3} fm, decrease nearly linearly with increasing neutron number in the investigated region 28 < or = N < or = 40. These isotope shifts are nearly independent of the proton configuration of the involved nuclei, hence, that the added neutrons interact primarily with the proton core rather than with the valence protons. A comparison of the experimental charge distribution differences with results of density dependent Hartree-Fock calculations indicates the importance of deformation changes. The core rearrangement due to added protons, deduced from the measured isotone charge distribution differences, and the core rearrangements due to added neutrons, directly measured by the isotope shifts, are similar. The last two nucleons of both the 1f/sub 7/2/ neutron and proton shell cause core polarizations, resulting in a smaller charge core radius.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 28095, 28117

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 28090, 28117

28091 (CONF-800551—3) **ORELA measurements to meet fusion energy neutron cross section needs.** Larson, D.C. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 13p. NTIS, PC A02/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

Major neutron cross section measurements made at the Oak Ridge Electron Linear Accelerator (ORELA) that are useful to the fusion energy program are reviewed. Cross sections for production of gamma rays with energies 0.3 < E/sub γ/ < 10.5 MeV were measured as a function of neutron energy over the range 0.1 < E/sub n/ < 20.0 MeV for Li, C, N, O, F, Na, Mg, Al, Si, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Nb, Mo, Ag, Sn, Ta, W, Au, Pb, and Th. Neutron emission cross sections have been measured for ^{7}Li, Al, Ti, Cu, and Nb for 1 < E/sub n/ < 20 MeV. Some results of recent neutron total cross section measurements from 2 to 80 MeV for eleven materials (C, O, Al, Si, Ca, Cr, Fe, Ni, Cu, Au, and Pb) of interest to the FMIT project are presented. Finally, future directions of the ORELA program are outlined. 4 figures, 3 tables.

28092 (LA-UR—80-1328) **Evaluation of neutron cross sections to 40 MeV for ^{54,56}Fe.** Arthur, E.D.; Young, P.G. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 21p. (CONF-800551—7). NTIS, PC A02/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

Cross sections for neutron-induced reactions on ^{54,56}Fe were calculated by employing several nuclear models: optical, Hauser-Feshbach, preequilibrium and DWBA - in the energy range between 3 and 40 MeV. As a prelude to the calculations, the necessary input parameters were determined or verified through analysis of a large body of experimental data for both neutron- and proton-induced reactions in this mass and energy region. This technique also led to cross sections in which the simultaneous influence of available data types added to their consistency and reliability. Calculated cross sections as well as neutron and gamma-ray emission spectra were incorporated into an ENDF evaluation suitable for use to 40 MeV. 12 figures, 1 table.

28093 (LBL—10721) **4π physics.** Sandoval, A. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 12p. (CONF-800329—3). NTIS, PC A02/MF A01.

From 1. workshop on nuclear dynamics; Tahoe City, CA, USA (17 Mar 1980).

Exclusive π^- and charged-particle production in collisions of ^{40}Ar on KCl are studied at incident energies from 0.4 to 1.8 GeV/A. The correlation between the π^- and the total charged particle multiplicity confines the reaction along a narrow ridge with no exotic islands of pion production. For high multiplicities the system reaches the total disintegration of target and projectile into singly charged fragments and pions. Every 200 MeV/A datum was taken with a central and inelastic trigger. For central collisions the mean π^- multiplicity increases linearly with the bombarding energy with no marked discontinuities due to the $\Delta(3,3)$ resonance. At 1.8 GeV/A evidence for nonthermal π^- production in central collisions is found. The total c.m. energy in π^- shows linear dependence on the π^- multiplicity with a slope of ϵ = 300 MeV/π^-. Strange particle production in the central collision of 1.8 GeV/A Ar on KCl is seen. 8 figures.

28094 (UCRL—84341) **Status of (n, charged particle) measurements at LLL.** Haight, R.C.; Grimes, S.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 16p. (CONF-800551—5). NTIS, PC A02/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

A charged-particle magnetic-quadrupole spectrometer was used to study (n, charged particle) reactions on materials bombarded with 14- to 15-MeV neutrons. Charged-particle production cross sections, angular distributions, and spectra were measured. The materials investigated to date include most of those proposed for fusion reactor structures, Al, Ti, Cr, V, Fe, Ni, Cu, Nb, and stainless steels 304 and 316. Isotopic data on ^{46,48}Ti, ^{50,52}Cr, ^{54,56}Fe, ^{58,60}Ni, and ^{63,65}Cu and on the monoisotopic elements ^{27}Al, ^{51}V, and ^{93}Nb provided stringent tests of reaction model calculations. Equilibrium and pre-equilibrium reaction mechanisms were identified and quantified. Preliminary data on ^{92,94,95,96}Mo and on light nuclides including ^{12}C and ^{7}Li were obtained recently. 8 figures, 1 table.

28095 **Valence neutron capture γ-ray spectrum in ^{54}Fe.** Raman, S.; Slaughter, G.G.; Wells, J.C. Jr.; Allen, B.J. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **22**: No. 1, 328-331(Jul 1980).

Neutron capture γ-ray spectra have been measured from the 7.76-keV s-wave and the 9.48-, 11.2-, and 14.4-keV p-wave resonances in ^{54}Fe. The 7.76-keV resonance spectrum is in excellent agreement with valence model predictions.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

28096 (LA-UR—80-1327) **Calculation of ^{59}Co neutron cross sections between 3 and 50 MeV.** Arthur, E.D.; Young, P.G.; Matthes, W.K. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 20p. (CONF-800551—8). NTIS, PC A02/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

Knowledge of the ^{59}Co(n,p), (n,α), and (n,xn) cross sections up to 50 MeV are necessary to satisfy priority dosimetry data needs of the FMIT facility. Since experimental data extend only to 25 MeV in the case of (n,xn) reactions (and lower energies for the others), these cross sections as well as those from competing reactions were calculated for neutron energies between 3 and 50 MeV.

Neutron optical parameters were determined that were valid from several hundreds of keV to 50 MeV. Other parameters were determined or verified through analysis of various experimental data types. A basis for complete and consistent nuclear model calculations of n + ^{59}Co reactions was thus provided. 9 figures, 1 table.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 28090

ENERGY LEVELS AND TRANSITIONS

28097 Evidence for ground and both neutron and proton rotational aligned bands in ^{68}Ge. de Lima, A.P.; Hamilton, J.H.; Ramayya, A.V.; van Nooijen, B.; Ronningen, R.M.; Kawakami, H.; Piercey, R.B.; de Lima, E. (Vanderbilt Univ., Nashville, TN (USA). Dept. of Physics). *Phys. Lett., B;* **83**: No. 1, 43-47(23 Apr 1979).

From in-beam, γ-ray spectroscopy, the yrast band in ^{68}Ge is found to branch into three positive parity bands at 8$^+$. Bands built on both the yrast 8$^+$ and second 8$^+$ levels show strong backbending in I while the third is apparently a continuation of the ground band. The two lowest 8$^+$ bands provide the first evidence for both proton and neutron rotation-aligned bands built on the same configuration in the one nucleus, here (g/sub 9/2/)^2. Rotational aligned model calculations confirm these assignments.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 28090, 28091, 28094, 28096

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

REFER ALSO TO CITATION(S) 28085, 28109

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 28099

28098 (LA—8365-MS) PEFPYD: a library of aggregate fission-product decay data derived from ENDF/B-IV. LaBauve, R.J.; George, D.C. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 19p. NTIS, PC A02/MF A01.

Results from summation calculations by the CINDER-10 and peripheral codes and fission-product decay, cross section, and yield data from the ENDF/B-IV were incorporated into a processed ENDF/B fission-product and energy-yield data (PEFPYD) library. The organization and content of this basic fine-group source-term library are described. The library contains aggregate beta and gamma spectra produced by neutrons of one or more energies incident upon six important nuclides. Although the PEFPYD library is described in other Los Alamos Scientific Laboratory reports, it is the purpose here to provide concise documentation for the library alone. 7 figures, 2 tables.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 28102, 28103

28099 Nuclear data sheets for A=145. Tuli, J.K. (National Nuclear Data Center, Brookhaven National Laboratory, Upton, New York 11973, USA). EY-76-C-02-0016. *Nucl. Data Sheets;* **29**: No. 3, 533-585(Mar 1980).

Experimental nuclear structure data are presented for all known nuclides with mass 145.

28100 High-spin states above 3.5 MeV in ^{91}Nb. Fields, C.A.; Kraushaar, J.J.; Ristinen, R.A.; Samuelson, L.E. (Colorado Univ., Boulder (USA). Nuclear Physics Lab.). *Nucl. Phys., A;* **326**: No. 1, 55-64(3 Sep 1979).

High-spin states in ^{91}Nb populated by the ^{89}Y(α, 2nγ) reaction were studied at 24.0 MeV and 35.7 MeV incident α-particle energy. Gamma-gamma coincidence and γ-ray angular distribution measurements were made. Several high-spin states in ^{91}Nb were observed at 35.7 MeV bombarding energy which were not observable at 24.0 MeV. The shell model structure of these states is discussed.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 28094, 28100

28101 (UCRL—84344) Study of optical model parameters for high energy neutron cross sections from 5 to 50 MeV in the mass-140 region. Phillips, T.W.; Camarda, H.S.; White, R.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 May 1980. Contract W-7405-ENG-48. 13p. (CONF-800551—2). NTIS, PC A02/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

A study of the neutron optical potential on nuclei near mass-140 was begun to extend the energy range and improve the precision of previous neutron total cross section measurements. The extended energy range of this measurement reveals maxima and minima in the total cross section that are evidence of the nuclear Ramsauer effect. A 100-MeV linear accelerator is used to produce a continuum of neutron energies from a Ta-Be conversion target. A 250-meter flight path is used to measure neutron energies by the time-of-flight method. Transmission data for ^{140}Ce and transmission ratios for ^{142}Ce, ^{141}Pr, and ^{139}La relative to ^{140}Ce were obtained. The ^{140}Ce data have a precision of 1 to 3% and the ratios are obtained with a precision of about 0.3%. To analyze these total cross section data a computer code was developed to calculate the total elastic, reaction, and differential elastic scattering cross sections for a neutron interacting with a nucleus. The interaction is represented by a spherically symmetric complex potential that includes spin-orbit coupling. The parameters of this potential were adjusted to approximate the ^{140}Ce total cross over the energy range from 2.5 to 60 MeV. The energy dependence of these parameters is described. 5 figures, 1 table.

28102 Analyzing power measurements for two-nucleon transfer reactions in a shape transitional nucleus. Flynn, E.R.; Brown, R.E.; Cizewski, J.A.; Sunier, J.W.; Alford, W.P.; Sugarbaker, E.; Ardouin, D. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **22**: No. 1, 43-50(Jul 1980).

Measurements of the analyzing power in the two-nucleon transfer reaction (t,p) have been carried out leading to ^{98}Mo and to the transitional nucleus ^{102}Mo where shape coexistence states are expected. Because of the sensitivity of the shapes of analyzing powers to the reaction mechanism, such data may be useful in determining the basic parentage of excited states in these nuclei through the interference of second order processes. A comparison of the ground state and strong excited 0$^+$ state transitions shows no large differences in the shapes of analyzing powers nor are any observed in L=2 transitions.

28103 Separation of proton and deuteron spin-dependent effects in the ^{116}Sn(d,p)^{117}Sn reaction. Cadmus, R.R. Jr.; Haeberli, W. (Wisconsin Univ., Madison (USA)). *Nucl. Phys., A;* **327**: No. 2, 419-438(24 Sep 1979).

The cross section, vector analyzing power and proton polarization have been measured for the l/sub n/ = 0 reaction ^{116}Sn(d,p)^{117}Sn(g.s.) at 8.22 MeV. In addition, cross section and analyzing power data have been obtained at 8.22 MeV for ^{116}Sn(d(pol),d)^{116}Sn and for ^{116}Sn(d,p)^{117}Sn leading to excited states of ^{117}Sn at 0.159, 0.317, 1.020, 1.179, 1.308 and 1.497 MeV. The cross section and analyzing power for ^{117}Sn(p(pol),p)^{117}Sn and for ^{117}Sn(p(pol),d)^{116}Sn leading to the 1.294 MeV state of ^{116}Sn have also been measured at 12.91 MeV. The data for ^{116}Sn(d,p)^{117}Sn(g.s.) have been used to separate the contributions to the analyzing power arising from spin-dependent forces in the proton and deuteron channels. A similar analysis is presented for an l/sub n/ = 0 ^{90}Zr(d,p)^{91}Zr transition at 11 MeV. Optical-model analyses have been performed for the elastic scattering data. The reaction data have been compared with distorted-wave calculations in order to investigate the validity of various deuteron potentials, as well as to extract spectroscopic information.

28104 Mutual excitation of ^{22}Ne and ^{126}Te in inelastic scattering. Cleary, T.P.; Ford, J.L.C. Jr.; Gross, E.E.; Hensley, D.C. (Oak Ridge National Lab., TN (USA)); Bingham, C.R.; Vrba, J.A. (Tennessee Univ., Knoxville (USA)). *Phys. Lett., B;* **83**: No. 1, 51-54(23 Apr 1979).

Angular distribution data for the mutual excitation of the ^{126}Te and ^{22}Ne 2$^+$ states have been measured for the inelastic scattering of 93.5 MeV ^{22}Ne on ^{126}Te. Data for transitions to the ground states, the ^{126}Te 2$^+$ state and the ^{22}Ne 2$^+$ state were also obtained. A coupled-channels analysis of the reaction is found to provide a good description of the general features of the data.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

REFER ALSO TO CITATION(S) 28109

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 28106

28105 Single-proton states in ^{175}Tm studied with the (t(pol),α) reaction. Lovhoiden, G.; Andersen, P.H. (Bergen Univ. (Norway)); Burke, D.G. (McMaster Univ., Hamilton, Ontario (Canada). Tandem Accelerator Lab.); Flynn, E.R.; Sunier, J.W. (Los Alamos Scientific Lab., NM . *Nucl. Phys., A;* **327**: No. 1, 64-76(17 Sep 1979).

The ^{176}Yb(t(pol),α)^{175}Tm reactions has been studied using 17 MeV tritons with a polarization of approximately 0.78 from the Los Alamos tandem Van de Graaff accelerator facility. The reaction products were momentum analyzed with a Q3D magnetic spectrometer and detected with a helical-cathode position-sensitive proportional counter. No nuclear structure information is available in the literature for the neutron-rich ^{175}Tm isotope. A comparison of the measured angular distribution for the (t(pol),α) reaction with DWBA predictions permitted spin and parity assignments for many levels. Rotational bands have been assigned for the $1/2^+$[411], $7/2^-$[523], $3/2^+$[411], $5/2^+$[413] and $5/2^-$[532] orbitals, and tentative suggestions are given for the location of the $5/2^+$[402] and $7/2^+$[404] Nilsson states. For the weakly populated band members the assignments rest strongly on the Nilsson model and are based mostly on energy relations and comparison with experimental population patterns observed in neighbouring nuclei for the same orbitals.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 28105, 28109

28106 Evidence for nuclear shape coexistence at N=88: ^{152}Eu(d,p) and (d,t) reactions. Lanier, R.G.; Struble, G.L.; Mann, L.G.; Oelrich, I.C.; Proctor, I.D.; Heikkinen, D.W. (Nuclear Chemistry Division, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **22**: No. 1, 51-64(Jul 1980).

The (d,p) and (d,t) reactions on an isotopically enriched radioactive target of ^{152}Eu were investigated at a deuteron bombarding energy of 20 MeV. The triton spectrum showed the following features: (1) levels in ^{151}Eu below ~ 260 keV were virtually unpopulated, (2) the pickup strength of one-quasiparticle states is severely fragmented and is spread over a group of levels between ~ 260 and ~ 950 keV, and (3) the majority of the pickup strength is concentrated in a narrow band of levels between ~ 2.3 and ~ 2.8 MeV. An analysis of these data in conjunction with other available information on the structure of ^{151}Eu suggests the coexistence of three distinct shapes in ^{151}Eu: states related to the ground state are spherical, states related to a $5/2^+$ state at 260 keV are moderately deformed, and states between ~ 2.3 and ~ 2.8 MeV are strongly deformed and are essentially one-neutron holes coupled to a two-quasiparticle configuration which is identical to the ground state structure of ^{152}Eu. The spectrum observed in the (d,p) reaction shows that the ^{153}Eu $5/2^+$ ground state rotational band is weakly populated to I=11/2, but shows few other states below ~ 2 MeV. The intensity patterns and angular distributions for the ^{153}Eu ground band are consistent with pure l=5 transfer to the ^{153}Eu {π5/2[413], ν11/2[505]}/sub K/=3 ground state.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

REFER ALSO TO CITATION(S) 28085, 28109, 28110

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 28107

NUCLEAR REACTIONS AND SCATTERING

28107 (COO—4215-3, pp 7, 31-32) **Large angle ^{116,124}Sn, ^{208}Pb elastic scattering.** 1979.

In University of Minnesota progress report No. 4215.

The angular distribution from ^{208}Pb(p,p) reactions at 800 MeV is shown. The neutron density rho/sub n/(r) determined from this experiment is plotted, together with that from a Hartree-Fock calculation. 2 figures. (RWR)

28108 Cross-section measurements of nuclides formed by the reaction of 0.20 — 6.0 GeV protons with ^{197}Au. Kaufman, S.B.; Steinberg, E.P. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *Phys. Rev., C;* **22**: No. 1, 167-178(Jul 1980).

Cross sections of a number of radioactive products formed by the reaction of protons with ^{197}Au have been measured at bombarding energies of 0.20, 0.49, 1.0, 3.0, and 6.0 GeV. The excitation functions for specific nuclides exhibit several different types of behavior which are characteristic of the reaction mechanisms involved. Spallation products have excitation functions which rise rapidly above an energetic threshold, go through a maximum, and then decrease again, finally approaching a constant cross section at the highest energies. The excitation functions of light nuclides do not exhibit such a peak, but increase monotonically to the asymptotic high-energy limit. Mass-yield distributions are derived from the data, and are compared with the results of intranuclear cascade-evaporation calculations. Comparison of the mass-yield distribution for protons with those for incident pions shows that the rest energy of the pion is as effective in transferring excitation energy to the target as the same amount of kinetic energy.

28109 Angular momentum transfer in deep inelastic scattering. Experiment and theory. Moretto, L.G. (California Univ., Berkeley (USA). Dept. of Chemistry). *S.Afr. J. Phys.;* **1**: No. 3-4, 181-182(1978).

From International conference on dynamical properties of heavy-ion reactions; Johannesburg, South Africa (1 - 3 Aug 1978).

The measured γ-ray multiplicities as a function of exit channel kinetic energy and mass asymmetry for the reactions Au, Ho, Ag + 620 MeV Kr are compared with a diffusion calculation based exclusively upon particle transfer and which reproduces the Z distributions as well as the angular distributions as function of Z. The model correctly predicts the energy and Z dependence of the γ-ray multiplicities, thus lending support to the one-body model on one hand and to the angular-momentum fractionation along the mass asymmetry coordinate on the other.

28110 Equilibration in the reaction of 175 and 252 MeV ^{20}Ne with ^{197}Au. Moulton, J.B. Berkeley, CA; Univ. of California (1978). 165p. University Microfilms Order No. 79-14,707.

Thesis (Ph. D.).

The highly inelastic nuclear reaction of ^{197}Au with ^{20}Ne at 175 and 252 MeV laboratory energies was studied. Energy, elemental, and angular distributions for atomic numbers 5 to 30 (175 MeV) or 34 (252 MeV are presented). The means and widths of the kinetic energy spectra for detected elements are compared with a theoretical calculation. The calculation postulates thermalization of the incident projectile kinetic energy, and includes one shape-vibrational degree of freedom and rigid rotation of the reaction complex. The effect of particle evaporation is considered. Good agreement of the experimental mean energies with the theory is obtained. Poorer agreement of the kinetic energy widths with the theory may be due to a low-temperature quantal effect. The relative elemental yields are analyzed for their degree of equilibration, on the basis of a model of diffusive nucleon exchange as described by the master equation. A similar degree of equilibration is observed for both reaction energies. The absolute elemental yields are reproduced qualitatively by employing an advanced diffusion code, coupled with calculation of the subsequent fission of heavy reaction products, including the compound nucleus. The angular distributions are analyzed with a simple model, to estimate the reaction lifetime of selected elements.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL

SPONTANEOUS AND INDUCED FISSION

28111 (RLO—1388-442) **Search for the instantaneous fission in the Pb + U system.** Metag, V.; Doubre, H.; Lazzarini, A.; Norman, E.B.; Puigh, R.J.; Seamster, A.G.; Vandenbosch, R. (Washington Univ., Seattle (USA). Nuclear Physics Lab.). 1979. Contract AC06-76ER01388. 11p. NTIS, PC A02/MF A01.

A theoretical prediction for the occurrence of instantaneous fission in the bombardment of U with 1400 MeV Pb has been tested. The experimental upper limit is two orders of magnitude smaller than the expected cross section.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

28112 (UCRL—84342) **Neutron scattering cross sections for ^{232}Th and ^{238}U inferred from proton scattering and charge exchange measurements.** Hansen, L.F.; Grimes, S.M.; Pohl, B.A.; Poppe, C.H.; Wong, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 20p. (CONF-800551—6). NTIS, PC A02/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

Differential cross sections for the (p,n) reactions to the isobaric analog states (IAS) of ^{232}Th and ^{238}U targets were measured at 26 and 27 MeV. The analysis of the data was done in conjunction with the proton elastic and inelastic (2^+, 4^+, 6^+) differential cross sections measured at 26 MeV. Because collective effects are important in this mass region, deformed coupled-channels calculations were carried out for the simultaneous analysis of the proton and neutron outgoing channels. The sensitivity of the calculations was studied with respect to the optical model parameters used in the calculations, the shape of the nuclear charge distribution, the type of

coupling scheme assumed among the levels, the magnitude of the deformation parameters, and the magnitude of the isovector potentials, V_1 and W_1. A Lane model-consistent analysis of the data was used to infer optical potential parameters for 6- to 7-MeV neutrons. The neutron elastic differential cross sections obtained from these calculations are compared with measurements available in the literature, and with results obtained using neutron parameters from global sets reported at these energies. 7 figures, 3 tables.

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 28098, 28118

28113 (CONF-800607—44) **High resolution measurement of the ^{231}Pa(n,f) cross section from 0.4 eV to 12 MeV.** Plattard, S.; Auchampaugh, G.F.; de Saussure, G. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92 - Montrouge (France); Los Alamos Scientific Lab., NM (USA); Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 6p. NTIS, MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

Portions of document are illegible.

The ^{231}Pa(n,f) reaction was studied to shed light on the existence of a shallow third minimum in the ^{232}Pa fission barrier. Results are plotted along with data points derived from ENDF/B-V. The occurrence of a pure vibrational state at E/sub n/ = 156.7 keV (3^+) together with a nearby state of opposite parity favors the evidence for a third asymmetrically deformed minimum in the ^{232}Pa fission barrier. 2 figures. (RWR)

28114 **Mass distributions in monoenergetic-neutron-induced fission of ^{232}Th.** Glendenin, L.E.; Gindler, J.E.; Ahmad, I.; Henderson, D.J.; Meadows, J.W. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *Phys. Rev., C;* **22**: No. 1, 152-159(Jul 1980).

Fission product yields for 38 masses were determined for the fission of ^{232}Th with essentially monoenergetic neutrons of 2.0, 3.0, 4.0, 5.9, 6.4, 6.9, 7.6, and 8.0 MeV. Fission product activities were measured by Ge(Li) γ-ray spectrometry of irradiated ^{232}Th foils and by chemical separation of the fission product elements followed by β counting. The mass yield data for ^{232}Th(n,f) show a sensitive increase of fission yields in the near-symmetric mass region (valley) with increasing incident neutron energy E/sub n/ and a pronounced dip in yield at the onset of second-chance fission just above the neutron binding energy (at ~ 6 MeV) where the excitation energy is lowered by competition with neutron evaporation prior to fission. The effect of second-chance fission is also seen in the yields of asymmetric peak products. A distinct third peak is observed at symmetry in the valley of the mass distribution, and enhanced yields are observed in the asymmetric peaks at masses associated with even Z (proton pairing effect). The fission yeilds of ^{232}Th(n,f) are compared with those of ^{235}U(n,f) and ^{232}Th(γ,f).

NUCLEAR THEORY

NUCLEAR STRUCTURE

REFER ALSO TO CITATION(S) 28117

28115 **Abnormal occupation and two-body correlations.** de Llano, M.; Plastino, A.; Zabolitzky, J.G. (Iowa State University, Physics Department, Ames Laboratory, U. S. Department of Energy, Ames, Iowa 50011). W-7405-ENG-82. *Phys. Rev., C;* **22**: No. 1, 314-315(Jul 1980).

It is shown that abnormal occupation, as found in a previous paper, does not occur if one allows for two-body correlations.

NUCLEAR MATTER

REFER ALSO TO CITATION(S) 28115

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 28082, 28119, 28176

28116 (UCRL—84369) **Recent developments in nuclear reaction theories and calculations.** Gardner, D.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 May 1980. Contract W-7405-ENG-48. 35p. (CONF-800551—11). NTIS, PC A03/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

A brief review is given of some recent developments in the fields of optical model potentials; level densities; and statistical model, precompound, and direct reaction codes and calculations. Significant developments have occurred in all of these fields since the 1977 Conference on Neutron Cross Sections, which will greatly enhance the ability to calculate high-energy neutron-induced reaction cross sections in the next few years. 11 figures, 3 tables.

28117 **Experimental demonstration of phase relation for common doorway states.** Mitchell, G.E.; Dittrich, T.R.; Bilpuch, E.G. (Triangle Universities Nuclear Lab., Durham, NC). pp 696-698 of Neutron capture gamma-ray spectroscopy. Chrien, R.E.; Kane, W.R. (eds.). New York, NY; Plenum Publishing Corp. (1979).

A recently developed technique permits the measurement of the relative sign of inelastic decay amplitudes of resonances. Results for a fragmented analog state establish that, for an isolated common doorway, the product of the amplitudes has the same sign for all individual resonances. 1 figure.

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 28233

SPONTANEOUS AND INDUCED FISSION

28118 (STI/PUB—526(Vol.1)) **Physics and chemistry of fission, 1979.** (International Atomic Energy Agency, Vienna (Austria)). 1980. 340p. (In several languages). (CONF-790507—(Vol.1)). IAEA.

From IAEA symposium on physics and chemistry of fission; Julich, F.R. Germany (14 May 1979).

This volume contains papers on the topics of fission barriers and probabilities, spontaneous fission and fission barriers, shell effects in potential energies and level densities, and fission and heavy ions. Thirty papers (mostly of a review nature) are included; most are in English. Two have already been cited in ERA, and can be found by reference to the entry CONF-790507— in the Report Number Index. The remaining papers will be processed as they are received on ATOMINDEX tapes. (RWR)

NUCLEAR MODELS

REFER ALSO TO CITATION(S) 28116

28119 **Radial sensitivity of elastic scattering.** Cramer, J.G.; DeVries, R.M. (Department of Physics, University of Washington, Seattle, Washington 98195). *Phys. Rev., C;* **22**: No. 1, 91-96(Jul 1980).

A new technique has been developed, employing a localized perturbation of the radial nuclear optical potential, which permits direct investigation of the sensitivities of optical model analysis of elastic scattering data to the details of the radial potential. It is found that both light- and heavy-ion scattering probe primarily the nuclear surface region. Higher energy scattering data probe further into the interior than lower energy data. The value of the potential at the center of the nucleus cannot be determined, but only inferred if a fixed parametrization such as Woods-Saxon geometry is specified. In addition, it is found that the region of radial sensitivity of the imaginary potential is systematically closer to the center of the nucleus than is that of the real potential.

28120 **Schematic model for monopole and quadrupole pairing in nuclei.** Ginocchio, J.N. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Ann. Phys. (N.Y.);* **126**: No. 1, 234-276(15 Apr 1980).

A schematic Hamiltonian with a pairing interaction plus a quadrupole—quadrupole interaction between nucleons is presented. It is shown that all the states of the fermion system can be classified according to the number of nucleons u not coupled to coherent monopole or quadrupole pairs. The states with u=0 are shown to have a one-to-one correspondence to the states of the interacting bosom model. The spectra for these states are derived analytically for various limits of the pairing strength and the quadrupole strength. Analytical forms for the matrix elements of opeators are derived for these limits. The operators in fermion space are mapped onto boson operators. The matrix elements of operators in the fermion space are shown to be equal to matrix elements of the boson operators multiplied by analytical Pauli factors which are state dependent. The two-nucleon transfer strength is calculated in two limits and is compared to experimental values.

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 28019

28121 (CONF-800471—4) **MORSE: current status of the two Oak Ridge versions.** Emmett, M.B.; West, J.T. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 10p. NTIS, PC A02/MF A01.

From Seminar on theory and applications of Monte Carlo methods; Oak Ridge, TN, USA (Apr 1980).

There are two versions of the MORSE Monte Carlo radiation transport computer code system at Oak Ridge National Laboratory. MORSE-CG is the most well-known and has undergone extensive use for many years. Development of MORSE-SGC was originally begun in order to restructure the cross section handling and thereby save storage, but the more recent goal has been to incorporate some of the KENO ability to handle multiple arrays in the geometry and to improve on 3-D plotting capabilities. New capabilities recently added to MORSE-CG include a generalized form for a Klein Nishina estimator, a new version of BREESE, the albedo package, which now allows multiple albedo materials and a revised DOMINO which handles DOT-IV tapes.

28122 (DOE/ER/03158—85) **Modifications to the TRIM Monte Carlo simulation program.** Macrander, A.T. (Cornell Univ., Ithaca, NY (USA)). Apr 1979. Contract AS02-76ER03158. 42p. NTIS, PC A03/MF A01.

Extensive modifications were made to the TRIM (TRansport of Ions in Matter) Monte Carlo computer code which simulates the ion irradiation of amorphous solids. The original FORTRAN code was translated into BASIC for use on minicomputers with 32 K words of memory. Versions have been written to simulate very low-energy irradiations and the irradiation of binary alloys. Furthermore, a version was written which added the capability of following a lateral direction, in addition to the penetration depth of an ion. Subsequently, a version was written to simulate the production of collision cascades. Details of these modifications were discussed and examples of their use were given.

28123 (DOE/EV/02386—1) **Interaction of radiation with matter. Proposed technical program, November 1, 1979-October 31, 1980.** Brandt, W.; Pope, M. (New York Univ., NY (USA). Dept. of Physics). Oct 1979. Contract AS02-76EV02386. 15p. NTIS, PC A02/MF A01.

A summary is presented of research in the interaction of radiation with matter. Areas of study include: environmental; photophysics; spectroscopic studies of polycyclic aromatic hydrocarbon carcinogen-DNA complexes; reactions of polycyclic aromatic hydrocarbons adsorbed on metal oxide particles in the presence of oxygen and other pollutant gases; energy-loss effect in inner-shell excitations; very-low velocity Coulomb deflection effects in K- and L-shell excitations; development of high-vacuum target chamber for acceleration studies of low-energy ion-solid interactions; dynamic response of solids to slow ions; wakes in solids; statistical mechanics of particles in constrained area; and stopping power of nearly degenerate media. (GHT)

28124 (UCID—18634) **Comparison between calculation and measurement of energy deposited by 800 MeV protons.** Loewe, W.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Apr 1980. Contract W-7405-ENG-48. 26p. NTIS, PC A03/MF A01.

The High Energy Transport Code, HETC, was obtained from the Radiation Shielding Information Center (RSIC) at Oak Ridge National Laboratory and altered as necessary to run on a CDC 7600 using the LTSS software in use at LLNL. HETC was then used to obtain calculated estimates of energy deposited, for comparison with a series of benchmark experiments done by LLNL. These experiments used proton beams of various energies incident on well-defined composite targets in good geometry. In this report, two aspects of the comparison between calculated and experimental energy depositions from an 800 MeV proton beam are discussed. Both aspects involve the fact that workers at SAI had previously used their version of HETC to calculate this experiment and reported their comparison with the measured data. The first aspect addressed is that their calculated data and LLNL calculations do not agree, suggesting an error in the conversion process from the RSIC code. The second aspect is not independent of the first, but is of sufficient importance to merit separate emphasis. It is that the SAI calculations agree well with experiments at the detector plate located some distance from the shower plate, whereas the LLNL calculations show a clearcut discrepancy there in comparison with the experiment. A contract was let in January 1980 by LLNL with SAI in order to obtain full details on the two cited aspects of the comparison between calculated and experimental energy depositions from an 800 MeV proton beam. The ensuing discussion is based on the final report of that contracted work.

28125 Radiation spectra and angular distribution of emitted quanta for planar channelled particles: radiation of single particle. Kheifets, S.; Knight, T. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-76SF00515. *J. Appl. Phys.;* **51**: No. 7, 3863-3868(Jul 1980).

A method of calculating the radiation characteristics for the motion in an arbitrary one-dimensional potential is developed. Expressions for channelling radiation frequencies, polarization angles, and the number of emitted photons as functions of quanta angles, particle energy, amplitude of oscillations, and divergence in a plane parallel to the trapping crystal planes for any given harmonic number are found. The problem is treated in the classical approximation. Numerical examples of the application of the derived formulae for channelling in the (1,1,0) direction of a silicon crystal are given. The results are presented both for electrons and positrons. Comparison of the calculation results for two choices of continuum potential for positrons is also given.

28126 Improved calculation of photoneutron yields released by incident electrons. Swanson, W.P. (Stanford Linear Accelerator Center, CA (USA)). *Health Phys.;* **37**: No. 3, 347-358(Sep 1979).

Calculations are presented of yields of low-energy neutrons released by electrons incident on semi-infinite targets of natural C, Al, Fe, Ni, Cu, Ag, Ba, Ta, W, Au, Pb and U. Yields are based on photon differential track-length distributions derived for semi-infinite targets from Approximation B of analytical shower theory. By the introduction of additional corrections in the treatment of the photon track-length distributions, calculational accuracy in the electron energy region near the photoneutron threshold is considerably improved over a previous report (SLAC-PUB-2042, Rev (1978); Health Phys. 35, 353, 1978.) The calculations confirm the yields of the previous report for high incident electron energies but show them to be overestimates close to threshold. Systematics of yields are re-examined and a parameterization is offered which can be used to estimate yields very close to the threshold for any material. ResuLts are relevant to the energy range used for radiation therapy.

28127 Stability of ionically bonded surfaces in ionizing environments. Knotek, M.L.; Feibelman, P.J. (Sandia Lab., Albuquerque, NM). *Surf. Sci.;* **90**: 78-90(1979).

Criteria are presented for the stability of ionic materials in ionizing environments, confining ourselves to cases where the core hole Auger decay mechanism of Knotck and Feibelman is applicable. The main result is that Auger induced decomposition will not occur unless the cation species in the solid is ionized down to a relatively deep filled shell. The shell must be sufficiently deep that an Auger decay starting from it will release the energy necessary for decomposition. The degree to which covalency in bonding affects stability is discussed. These concepts can be applied by examination of the periodic table and a table of electron binding energies.

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 28121, 28256, 28257

28128 (ANL—80-60) **Time-independent one-speed neutron transport equation with anisotropic scattering in absorbing media.** Hangelbroek, R.J. (Argonne National Lab., IL (USA)). Jun 1980. Contract W-31-109-ENG-38. 48p. NTIS, PC A03/MF A01.

This report treats the time-independent, one-speed neutron transport equation with anisotropic scattering in absorbing media. For nuclear gain operators existence and uniqueness of solutions to the half-space and finite-slab problems are proved in L_6-space. The formulas needed for explicit calculations are derived by the use of perturbation theory techniques.

28129 (CONF-800607—41) **CSRL-V: an ENDF/B-V 227-group cross section library for criticality safety studies.** Ford, W.E. III; Westfall, R.M.; Diggs, B.R.; Webster, C.C.; Knight, J.R. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 5p. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

The AMPX system was used to generate a P_3 227-neutron-group master cross-section library containing data for all materials in the ENDF/B-V general purpose file. CSRL-V is a data base for the subsequent generation of problem-dependent fine- and/or broad-group cross sections for shipping cask calculations and other criticality safety analyses. The problem-dependent data can be used with codes such as KENO IV, ANISN, XSDRNPM, VENTURE, DOT, MORSE, etc. CSRL-V data can be coupled with photon-production and photon-interaction multigroup data produced with the AMPX system to produce coupled neutron-gamma cross-section libraries. Consideration was given to the resonance structure of prominent nuclei, the thresholds of important reactions, and various fission spectra. Data in the CSRL-V library were checked for first-order consistencies and tested in performance parameter calculations for a series of benchmark critical experiments. The CSRL-V library is available on magnetic tape. 1 table. (RWR)

28130 (ORNL/TM—7033) **Flux extrapolation models used in the DOT IV discrete ordinates neutron transport code.** Tomlinson, E.T.; Rhoades, W.A.; Engle, W.W. Jr. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 44p. NTIS, PC A03/MF A01.

The DOT IV code solves the Boltzmann transport equation in two dimensions using the method of discrete ordinates. Special techniques have been incorporated in this code to mitigate the effects of flux extrapolation error in space meshes of practical size. This report presents the flux extrapolation models as they appear in

DOT IV. A sample problem is also presented to illustrate the effects of the various models on the resultant flux. Convergence of the various models to a single result as the mesh is refined is also examined. A detailed comparison with the widely used TWOTRAN II code is reported. The features which cause DOT and TWOTRAN to differ in the converged results are completely observed and explained.

RADIATION PROTECTION STANDARDS

REFER ALSO TO CITATION(S) 27860

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 27068, 28025, 28051

28131 (CONF-800561—2) **Gauge fields and order.** Ulehla, M. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 10p. NTIS, PC A02/MF A01.

From International conference on ordering in two dimensions; Lake Geneva, WI, USA (28 May 1980).

The recently proposed geometric description of order in solids is applied to the problem of melting in 2 dimensions. After a brief description of the geometric approach, how the dislocation-mediated theory of 2d melting arises in this formulation is explained.

28132 (SAND—80-0486C) **Interactions between small-polaronic particles in solids.** Emin, D. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 5p. (CONF-800647—1). NTIS, PC A02/MF A01.

From International conference on the physics of MOS insulators; Raleigh, NC, USA (18 Jun 1980).

When a light particle in a solid composed of relatively heavy atoms is associated with substantial displacements of the equilibrium positions of the atoms immediately surrounding it, the composite entity may be regarded as being small polaronic. Many instances of self-trapping of electronic charge carriers, excitons and light atoms such as hydrogen are known. A significant contribution to the interaction between such particles results from interference between their atomic displacement patterns. As a result oppositely charged small polarons may experience an intermediate-range repulsion, while both like-signed and neutral entities may have a tendency to cluster. These effects can be very important. As examples, the recombination kinetics of electron and hole small polarons and the ordering of defect atoms are discussed.

28133 **Spin—lattice relaxation of reorienting or tunneling deuterated methyl groups.** Tang, J.; Pines, A.; Emid, S. (Department of Chemistry, University of California, Lawrence Berkeley Laboratory, Berkeley, California 94720). *J. Chem. Phys.;* **73**: No. 1, 172-175(1 Jul 1980).

The spin—lattice relaxation of deuterated methyl groups, which is exponential at high temperatures, becomes nonexponential at low temperatures as evidence of the coupling between the Zeeman and tunneling systems. The dominant relaxation is considered to be the quadrupole interaction. Experimental results at liquid nitrogen and liquid helium temperatures support the theoretical model.

28134 **Correlations in ice-rule ferroelectrics.** Youngblood, R.; Axe, J.D.; McCoy, B.M. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B: Condens. Matter;* **21**: No. 11, 5212-5220(1 Jun 1980).

We discuss the character of long-wavelength polarization fluctuations in model ice-rule ferroelectrics. Because polarization is locally conserved in these systems, polarization correlations are strikingly different in character from those in systems having rotationally invariant correlations. Several aspects of the problem can be discussed quite fruitfully in the language of two-dimensional potential theory. Comparisons are made between predictions of this model family and neutron scattering experiments on a quasi-two-dimensional ice-rule ferroelectric, copper formate tetrahydrate.

28135 **Spin-wave theory of critical dynamics in one- and two-dimensional Heisenberg models: Failure of the dynamic-scaling hypothesis and the mode-coupling theory.** Reiter, G. (Texas A&M University, College Station, Texas 77843). *Phys. Rev., B: Condens. Matter;* **21**: No. 11, 5356-5363(1 Jun 1980).

The usual spin-wave theory, when applied to the calculation of rotationally invariant averages in the Heisenberg model, permits exact calculation of static and dynamical correlation functions in one dimension. The results are also believed to be exact in two dimensions, although this has not been shown rigorously here. The one-dimensional ferromagnet in the hydrodynamic regime and the two-dimensional ferromagnet at all wave vectors do not satisfy the dynamical scaling hypothesis. There is no characteristic exponent in these cases. The present results contradict the prediction of the mode-coupling theory.

28136 **Theoretical study of the Kondo lattice.** Jullien, R.; Pfeuty, P. (Paris-11 Univ., 91 - Orsay (France). Lab. de Physique des Solides); Fields, J.N. (Brookhaven National Lab., Upton, NY (USA)); Doniach, S. (Stanford Univ., CA (USA)). *J. Phys. (Paris), Colloq.;* No. 5, C5.293-C5.300(1979).

From International colloquium on physics of metallic rare earths; Saint-Pierre-de-Chartreuse, France (4 - 7 Sep 1978).

In order to understand the low temperature anomalous properties of rare earth compounds such as $CeAl_3$.$CeAl_3$, we introduce a Kondo lattice Hamiltonian by generalizing the Kondo impurity Hamiltonian to the concentrated case of one localized spin per site, interacting antiferromagnetically with the conduction electron spins. After discussing a more simple one dimensional analog, we study this hamiltonian at zero temperature by mean-field and renormalization group techniques. We show that the magnetism of the localized spins is destroyed by the formation of a singlet state with the conduction electron spins. Moreover, our latest results show that, when there is just one conduction electron per site, the system can become insulator for a sufficiently large Kondo coupling.

SUPERCONDUCTIVITY

28137 (IS-M—280) **AC losses in type-II superconductors.** Clem, J.R. (Ames Lab., IA (USA)). 1979. Contract W-7405-ENG-82. 66p. NTIS, PC A04/MF A01.

This lecture discusses the physics of ac losses in type-II superconductors and in multifilamentary superconducting-normal composite conductors. As an introduction, the ac eddy-current losses in a homogeneous normal conducting cylindrical specimen subjected to an alternating applied magnetic field are briefly reviewed. The ac losses in a superconducting cylindrical specimen next are discussed in detail, with emphasis on the loses in a specimen subjected to an alternating applied longitudinal magnetic field. In general, dissipation occurs via both flux-flow losses, which are analogous to eddy-current losses in the normal state, and hysteretic losses, which arise from bulk and surface pinning as well as annihilation of vortices of the opposite sense. Tests are suggested by which the dominant loss mechanisms can be identified. Finally, the losses in multifilamentary superconducting-normal composite conductors are reviewed.

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 27450, 27514

28138 (DOE/ER/02890—T1) **Flux pinning and flux flow studies in superconductors using flux flow noise techniques. Progress report, April 1-December 30, 1979.** Joiner, W.C.H. (Cincinnati Univ., OH (USA). Dept. of Physics). Dec 1979. Contract AS02-76ER02890. 48p. NTIS, PC A03/MF A01.

Flux flow noise power spectra were investigated, and information obtained through such spectra is applied to describe flux flow and pinning in situations where volume pinning force data is also available. In one case, the application of noise data to $PB_{80}In_{20}$ samples after recovery and after high temperature annealing is discussed. This work is consistent with a recent model for flux flow noise generation. In the second case we discuss experiments designed to change the fluxoid transit path length, which according to the model should affect both the noise amplitude and the parameter α specifying the longest subpulse times in terms of the average transit time, tau/sub c/. Transient flux flow voltages when a current is switched on after field cycling a $Pb_{60}In_{40}$ sample have been discovered. Noise spectra have been measured during the transient. These observations are discussed along with a simple model which fits the data. A surprising result is that the transient decay times increase with the applied current. Other characteristics of $Pb_{60}In_{40}$ after cold working are also discussed.

28139 **High magnetic field properties of CVD-prepared Nb_3Ge and $Nb_3(Ge,X^+)$.** Thompson, J.D.; Maley, M.P.; Newkirk, L.R.; Carlson, R.V. (Los Alamos Scientific Lab., NM). *IEEE Trans. Magn.;* **MAG-15**: No. 1, 516-519(Jan 1979).

Measurements of the field dependent critical current density, J/sub c/(H), and the upper critical field, H/sub c2/, have been performed on a number of Nb_3Ge samples prepared by the chemical vapor deposition (CVD) process. These samples, obtained from up to 20 m lengths of Nb_3Ge tape, were deposited on various substrates at temperatures between 835 and 950°C. Flux pinning, provided by the introduction of controlled amounts of second phase precipitate, Nb_3Ge_2, produced good high field properties with 4.2 K critical current densities on the order of 8.3×10^4 A/cm² at 18 T. Measurements of J/sub c/(H) performed on these samples in both liquid

helium and hydrogen in fields up to 18.5T have been analyzed in terms of Kramer's model of flux pinning. Qualitative agreement has been found with the scaling laws predicted by this theory. The effect of ternary additions of Si and Ga on both H/sub c2/ and J/sub c/(H) have been investigated as well. Contrary to expectation, the addition of ternaries into the A-15 lattice results in somewhat depressed critical characteristics. The effect of deposition parameters on the high field properties of both Nb_3Ge and $Nb_3(Ge,X)$ will be discussed.

28140 dHvA studies of A-15 superconductors at H ≦ 40 T. Arko, A.J. (Argonne National Lab., IL); Lowndes, D.H. *J. Magn. Magn. Mater.;* **11**: 225-232(1979).

Better single cystals, together with the use of high magnetic fields, have recently resulted in direct dHvA measurements of parts of the Fermi surfaces of the high T/sub c/ superconductors Nb_3Sn and V_3Si. The results of high precision band structure calculations are now beginning to appear for these materials, so that direct comparison of theory and experiment, for the electronic structure of at least some of the A-15 s, are now possible. The experimental data are reviewed in this paper in light of the available band structure results. Finally, the combined application of high precision quantum oscillation measurements and band structure calculations, to understand the structural transformation and defect behavior of A-15 materials, is briefly considered.

28141 Critical field effects of the Gd in Gd/sub x/Er/sub 1-x/Rh_4B_4. Wang, R.H.; Huang, C.Y.; Smith, J.L. (Los Alamos Scientific Lab., NM). *J. Phys. (Paris);* **39**: No. 8, 373-374(Aug 1978).

The effects of Gd ions on the superconducting transition temperature, the upper critical field, and the magnetic transition temperature of the Gd/sub x/Er/sub 1-x/Rh_4B_4 system were investigated for x = 0 to 1. The measured reentrant upper critical field curves are in reasonably good agreement with the theory of Fulde and Maki.

28142 Search for strong coupling superconductivity. Stewart, G.R.; Giorgi, A.L. (Los Alamos Scientific Lab., NM). *Solid State Commun.;* **28**: No. 12, 969-972(1978).

The specific heats of $Mo_{0.6}Re_{0.4}$ (BCC-phase), $Mo_{0.4}Re_{0.6}$ (Sigma-Phase), $Mo_{0.18}Tc_{0.82}$ (HCP-phase), and $W_{0.65}Re_{0.35}$ (BCC-phase) have been measured as part of the investigation of the basis for the extreme strong coupling previously found in the BCC and A-15 phase of $Mo_{0.4}Tc_{0.6}$. The normalized energy gaps, 2Δ/kT/sub c/, of the four compounds are found to be, respectively, 5.0, 3.4, 3.6, and 3.1. Thus, of these four compounds between VIB and VIIB elements, only the BCC phase, $Mo_{0.6}Re_{0.4}$ has strong coupling similar to the $Mo_{0.4}Tc_{0.6}$ materials. The implications of this result for defining the important parameters that cause strong coupling in $Mo_{0.4}Tc_{0.6}$ are discussed.

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

28143 (ORO—3992-379) **Gamow state vectors as functionals over subspaces of the nuclear space.** Bohm, A. (Texas Univ., Austin (USA). Center for Particle Theory). Dec 1979. Contract AS05-76ER03992. 11p. NTIS, PC A02/MF A01.

Exponentially decaying Gamow state vectors are obtained from S-matrix poles in the lower half of the second sheet, and are defined as functionals over a subspace of the nuclear space, PHI. Exponentially growing Gamow state vectors are obtained from S-matrix poles in the upper half of the second sheet, and are defined as functionals over another subspace of PHI. On functionals over these two subspaces the dynamical group of time development splits into two semigroups.

28144 (SAND—78-1154) **PENOB: a modification of the PENAP code to treat oblique impact of earth penetrators.** Yarrington, P.; Norwood, F.R.; Ruiz, N.K. (USAEC Division of Materials and Licensing, Washington, DC). Feb 1980. Contract AC04-76DP00789. 47p. NTIS, PC A03/MF A01.

As a direct extension of the work on normal penetration, effort was directed to develop analytical techniques for treating oblique impact (nonzero angle of attack and impact angle). The PENOB code was developed for this purpose from the equations of the PENAP axisymmetric earth penetration program. To treat oblique impact problems, the boundary conditions on the penetrator-soil interface are allowed to vary around the penetrator circumference. In general, peak lateral loads predicted by PENOB were fond to be larger (by factors of 1.5 to 2.0) than those obtained by earlier approximate methods. 8 figures, 5 tables.

28145 Semiclassical calculation of eigenvalues for a three-dimensional system. Noid, D.W.; Koszykowski, M.L.; Marcus, R.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **73**: No. 1, 391-395(1 Jul 1980).

A method utilizing integration along invariant curves on Poincare's surfaces of section is described for the semiclassical calculation of eigenvalues for three and higher dimensional systems, supplementing thereby our previous work in two dimensions. The eigenvalues calculated for anharmonically coupled oscillators agree well with the exact quantum eigenvalues.

28146 Exact solution of the Faddeev equations for the harmonic oscillator ground state. Friar, J.L.; Gibson, B.F.; Payne, G.L. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **22**: No. 1, 284-286(Jul 1980).

The Faddeev equations in N space dimensions for three identical spinless particles in their ground state interacting via harmonic oscillator, two-body potentials is solved analytically. Unlike the well-known Schroedinger solution, the individual Faddeev amplitudes may be negative and contain a long-range component of arbitrary strength. Upon symmetrizing to obtain the full wave function, this component vanishes and the Schroedinger solution results. Three-dimensional plots of the various wave functions are presented.

28147 Perturbation theory in large order. Bender, C.M. (Washington Univ., St. Louis, MO). *Adv. Math.;* **30**: No. 3, 250-267(Dec 1978).

For many quantum mechanical models, the behavior of perturbation theory in large order is strikingly simple. For example, in the quantum anharmonic oscillator, which is defined by $-y'' + (x^2/4 + ex^4/4 - E)y = 0, y(+-\infty) = 0$, the perturbation coefficients, A/sub n/, in the expansion for the ground-state energy, E(ground state) ~ E/sub n = 0//sup ∞/ A/sub n/ε/sup n/, simplify dramatically as $n \to \infty$: A/sub n/ ~ $(6/\pi^3)$/sup 1/2/(-3)/sup n/Γ(n + 1/2). Methods of applied mathematics are used to investigate the nature of perturbation theory in quantum mechanics and show that its large-order behavior is determined by the semiclassical content of the theory. In quantum field theory the perturbation coefficients are computed by summing Feynman graphs. A statistical procedure in a simple λ phi^4 model for summing the set of all graphs as the number of vertices → ∞ is presented. Finally, the connection between the large-order behavior of perturbation theory in quantum electrodynamics and the value of α, the charge on the electron, is discussed. 7 figures.

RELATIVITY AND GRAVITATION

REFER ALSO TO CITATION(S) 28074, 28076, 28154

OPTICS

REFER ALSO TO CITATION(S) 28255

28148 (SAND—80-0995) **Analysis of the point-diffraction interferometer and application to testing of pressure-loaded windows.** Riley, M.E.; Patterson, E.L. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 20p. NTIS, PC A02/MF A01.

A diffraction-theory analysis is given of the point-diffraction interferometer. The leading error present in the reference beam is expressed as a function of the pinhole diameter. A second part of the work presents a ray-tracing analysis of pressure-loaded windows; the leading-order distortion for incident plane waves is a weak lensing. The point-diffraction interferometer is used to confirm the analysis for an astigmatic aberration produced by cylindrical deformation of a plastic window.

STATISTICAL PHYSICS AND THERMODYNAMICS

28149 Dimensional model for the calculation of thermodynamic properties of gaseous molecules and ions. Frurip, D.J.; Blander, M. (Chemical Engineering Division, Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *J. Chem. Phys.;* **73**: No. 1, 509-518(1 Jul 1980).

A dimensional analysis of the classical partition function for ionic molecules leads to simple universal relations for the calculation of nonelectronic entropies and free energy functions. The model is tested for a large number of species with different stoichiometries and degrees of ionicity (MX, MX_2, M_2X_2, and ions MX/sup plus-or-minus1/). The success of these tests demonstrates the validity and usefulness of the model. Since the only quantities required for the calculation are the interatomic distance and atomic masses, this procedure can greatly simplify the calculation of these thermodynamic functions for an unknown species. As an illustration, calculated thermodynamic data are presented for the seven alkali halide dimers for which data are not available.

ELECTRICITY AND MAGNETISM

28150 (SAND—79-1401) **Admittance of an infinitely long monopole antenna immersed in a dissipative medium and driven by an air-**

filled coaxial line. Morris, M.E. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 23p. NTIS, PC A02/MF A01.

When monopole antennas are used to probe different media such as soil or water, the experiment is generally configured so that there is a dielectric interface between the medium being probed and the end of the coaxial line used to drive the antenna. In order to correlate the measurements with existing antenna theories and with other measurements, the effect of the interface on the admittance of the antenna must be determined. The infinite monopole antenna driven with a coaxial line was used as a model to determine this effect. The integral equation appropriate to this geometry has been numerically solved for a wide range of parameters and the surprising result has been determined that the interface affects the admittance only slightly compared to the more significant effect of changing the drive geometry. The capacitive admittance correction due to the dielectric interface can be ignored for most experimental purposes for antennas immersed in nondissipative media. In dissipative media the situation is more complex.

28151 (SAND—79-1557) **Analysis of a finite length tubular monopole antenna driven by a coaxial line.** Morris, M.E. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 44p. NTIS, PC A03/MF A01.

In this paper, the problem of a coaxially-driven, finite length tubular monopole antenna over an infinite ground plane is formulated as a rigorous boundary value problem. The resulting coupled pair of singular integral equations is numerically solved for the electric field in the end of the coaxial line and for the total current on the antenna. The electric field is used to compute the admittance of the antenna. The admittance, electric field, and current are presented for a wide range of experimentally useful parameters.

28152 Scattering of electromagnetic waves by a slowly rotating rectangular metal plate. Lahaie, I.J.; Sengupta, D.L. (Univ. of Michigan, Ann Arbor). *IEEE Trans. Antennas Propag.;* **27**: No. 1, 40-46(Jan 1979).

The amplitude modulation waveform of linearly polarized electromagnetic waves due to the scattering by slowly rotating metal plates are investigated theoretically and experimentally. The nature of the modulation waveform depends on the orientation and dimensions of the object, its rotation speed, and very strongly on the incident and receiving (or scattering) directions. For a rectangular metal plate rotating in its own plane, the modulation is independent of time in the specular and forward directions. Near the specular and forward directions the modulation waveform is a sinusoidal function having a frequency equal to twice the rotation frequency of the plate. Further away from these directions, the waveform is a sinc-pulse type repeating at twice the rotation frequency. Similar results are also discussed for a rotating skewed metal plate. The observed waveforms are found to be in good agreement with theoretical results.

MATHEMATICAL PHYSICS

28153 (ORNL/CSD—57) **Boundary integral equation method for fracture problems with mixed mode deformations.** Chang, S.J.; Morgan, R.B. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 51p. NTIS, PC A04/MF A01.

A numerical method which is based on the boundary integral equation formulation in elasticity is established to solve two-dimensional problems of linear fracture mechanics. The scheme requires the superposition of a crack problem in an infinite region and an elastic problem which does not contain the crack but has an identical outer boundary condition to that of the given problem. This method is useful in solving problems with a large class of regions. It is also capable of solving problems with mixed mode deformations and with the effect of plastic deformation in the form of strip yielding.

28154 (ORO—3992-384) **Supralgebras, supergroups and geometric gauging.** Ne'eman, Y. (Texas Univ., Austin (USA). Center for Particle Theory). Dec 1979. Contract AS05-76ER03992. 82p. NTIS, PC A05/MF A01.

(I) This highly mathematical part deals with superalgebras, supergroups, and supermanifolds under the following headings: supers enter physics and mathematics; superalgebras; superconformal and super-Poincare algebras; the Z(2) and Z graded Grassman rings: supermanifolds; the classification of simple Lie superalgebras; classical superalgebras: the superlinear (or superunitary) sequences; classical superalgebras: the orthosymplectic sequences; classical hyperexceptional and exceptional superalgebras; nonclassical superalgebras; and supergroups. (II) It appears plausible that some type of Supergravity might provide a unifying principle for Gravity and the other interactions. Gauging a supergroup has yielded an embedding of the Weinberg-Salam model of asthenodynamics in a highly constraining aesthetic theory. In this part, dealing with forms on a (rigid) group manifold, a principal bundle, and a soft (Dali) group manifold, the elements of the exterior calculus are developed on a Lie group manifold. Then the geometric theory of gauging is obtained; for a local internal symmetry, this is done on a principal bundle. For a noninternal group, such as the Poincare or super-Poincare group, Gravity and Supergravity are reproduced by use of a soft group manifold, i.e., a manifold the tangent of which is the original rigid group. The theory is expounded along according to the following program: differential geometry and Lie groups; examples: the Poincare and super-Poincare groups; gauge theory over a principal fiber bundle; ghosts and BRS equations; the soft group manifold; weakly reducible symmetric groups; geometric quadratic Lagrangian for WRSS groups; Gravity; and Supergravity.

28155 (UCRL—84116) **Matrix theory of elastic wave scattering: application to scattering of transverse waves.** Opsal, J.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Mar 1980. Contract W-7405-ENG-48. 6p. (CONF-790757—4). NTIS, PC A02/MF A01.

From ARPA/AF review of progress in quantitative NDE; La Jolla, CA, USA (8 Jul 1979).

New calculations of elastic wave scattering using Visscher's matrix theory have been made for transverse waves incident on axially symmetric defects. Longitudinal incident waves have also been considered with the results in agreement with those obtained previously by Visscher. A number of interesting features for incident transverse waves will be presented as well as some of the practical aspects of the calculation (e.g. convergence, accuracy, and computer time).

FUSION ENERGY

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

28156 (COO—4020-10) **Study of flow and loss processes at the ends of a linear theta pinch. Progress report, June 1, 1979-September 30, 1980.** York, T.M.; Klevans, E.H. (Pennsylvania State Univ., University Park (USA)). May 10080. Contract AS02-76-ET-53018. 68p. NTIS, PC A04/MF A01.

Experimental and analytical studies of particle and energy loss at the ends of a linear theta pinch have been carried out. A study of transients occurring in the formation of reversed trapped fields within the coil, and of transients in the end region of a 25 cm long device was completed. A 1-D code has proven to be highly accurate in describing loss events and defining transport mechanisms in different experiments and is described here. A study of loss along field lines in a 50 cm long device has generated new information on loss velocity, axial and radial temperature gradients, and has established an initial effort in understanding thermal loss to the walls. Rotation and parallel trapped fields have been added to the existing 0-D code. A new technique crowbar switch and magnetic field prediction code have been developed. Direct measurment of electron velocity with Thomson scattering was accomplished experimentally. A Nd-glass laser system, frequency doubled, is being developed for low density diagnostics. Theoretical results that accurately predict confinement in FRX devices are described.

28157 (UCRL—83505) **Tandem mirror reactors with thermal barriers.** Logan, B.G.; Arfin, B.; Barr, W.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 May 1980. Contract W-7405-ENG-48. 15p. (CONF-800707—3; IAEA-CN—38/E2). NTIS, PC A02/MF A01.

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Preliminary calculations of Q and magnet designs are presented for three different versions of tandem mirror reactors (TMR) using thermal barriers to enhance plug potentials by auxiliary electron heating. These three versions, called A-cell-barrier TMR, axisymmetric-barrier TMR, and inside-barrier TMR, exhibit reduced plug density ($n/\text{sub } p/ << 10^{19}$ m^{-3}) and less required magnetic mirror field ($B/\text{sub mirror} \simeq 9$ T) compared to TMR designs without thermal barriers. A-cell barrier TMR Q's range from 5 to 25 depending on the central-cell length ($L/\text{sub } c/ = 100$ to 200 m) and peak center-cell beta $\beta/\text{sub } c/$ (0.3 to 0.7) allowed by MHD stability. Axisymmetric-barrier TMR Q's range from 14 at $L/\text{sub } c/ = 100$ m to 30 at $L/\text{sub } c/ = 200$ m, if peak $\beta/\text{sub } c/ = 1$. From a global equilibrium model for the inside-barrier TMR, Q values greater than 15 are achieved for $\nu = 0.5$ in the modified Boltzmann relation for the plug potential. Even higher Q's are obtained using ECRF heating in the barrier to create a hot, mirror-trapped electron population. TMR's burning D-D as a fuel have been analyzed with a modified version of the global equilibrium model and under the assumption of an axisymmetric plug and barrier stabilized by surface magnetic fields. High-barrier mirror ratio is now feasible ($R/\text{sub } b/$

= 30-50), and short barrier length permits Q/sub DD/ values greater than 5.

28158 (UCRL—83515) **Plasma confinement experiments in the TMX tandem mirror. Paper IAEA-CN-38/F-1.** Simonen, T.C.; Anderson, C.A.; Casper, T.A. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). 22 May 1980. Contract W-7405-ENG-48. 12p. (CONF-800707—5). NTIS, PC A02/MF A01.

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Results from the new Tandem Mirror Experiment (TMX) are described. Tandem-mirror density and potential profiles are produced using end-plug neutral-beam injection and central-cell gas-fueling. TMX parameters are near those predicted theoretically. The end-plug electron temperature is higher than in the comparably sized single-mirror 2XIIB. Axial confinement of the finite-beta central-cell plasma is improved by the end plugs by as much as a factor of 9. In TMX, end-plug microinstability limits central-cell confinement in agreement with theory.

28159 (UCRL—83519(Rev.1)) **Studies in tandem mirror theory. Paper IAEA-CN-38/F-4.** Baldwin, D.E.; Cohen, R.H.; Cutler, T.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Jun 1980. Contract W-7405-ENG-48. 16p. (CONF-800707—2(Rev.1)). NTIS, PC A02/MF A01.

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

This paper discusses the formation, maintenance, and microstability of thermal barriers, which have been introduced as a means for improving tandem mirror reactor performance at reduced technological demands. It also describes calculations of tandem mirror central-cell β limits due to MHD ballooning modes.

28160 **Studies of the hot-electron population in an electron beam stabilized mirror-confined plasma.** Gerassimenko, M.; Petrasso, R.; Klinkowstein, R.E. (American Science and Engineering, Inc., 955 Massachusetts Avenue, Cambridge, Massachusetts 02139). EG-77-C-02-4541. *J. Appl. Phys.;* **51**: No. 7, 3960-3962(Jul 1980).

X-ray and diamagnetic loop measurements following electron beam injection into a hot ion plasma trapped in a minimum-B mirror system are reported. The hot electrons, believed to be responsible for the novel stabilization of the plasma by electron beam injection, are found to have a temperature kT~2—3 keV, and a density of about 1% of the plasma's at the midplane. Axially, the hot electrons are more widely distributed than the trapped ions.

28161 **Evolution of flux-conserving tokamak equilibria with pre-programmed cross sections.** Holmes, J.A.; Peng, Y.M.; Lynch, S.J. (Computer Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *J. Comput. Phys.;* **36**: No. 1, 35-54(Jun 1980).

The evolution of MHD equilibria toward high β is modeled by magnetic flux conservation with a given q(psi) and by single fluid particle and energy balances which determine p(psi, t). These one-dimensional flux surface averaged equations, written with magnetic flux psi as the independent varianle, are coupled to the two-dimensional MHD equilibrium equation through psi, p(psi, t), and q(psi). The location an evolution of the plasma cross section boundary are precisely specified through the use of a fixed boundary equilibrium technique. In moving boundary studies (e.g., plasma compression) the resulting system of equations is advanced in time from an inital state by a procedure which utilizes two nested predictor-corrector loops together with an implicit time-stepping technique. The inner predictor-corrector loop advances the transport equations subject to a given equilibrium configuration while the outer loop evolves the equilibrium. For fixed plasma boundaries this procedure is modified for greater computational speed. These techniques provide satisfactory numerical convergence together with complete consistency between the coupled one-dimensional system of equations and the two-dimensional equilibrium. This method can be applied to the study of equilibrium evolution involving dramatic changes of plasma position, shape, an profiles while prescribing the evolution of the plasma boundary. As such, it can serve as a useful tool in the design of poloidal field systems or as a source of equilibria in high-β MHD stability studies. As an example, the compressional scaling laws of Furth and Yoshikawa are found to be modified for small aspect ratio.

28162 **Alpha-particle heating in an open-field-line plasma.** Steinhauer, L.C. (Mathematical Sciences Northwest, Inc., Bellevue, WA (USA)). *Nucl. Fusion;* **20**: No. 1, 69-82(Jan 1980).

Ignited fusion plasmas have the potential of high-Q performance but only if charged-particle fusion products deposit a large share of their energy within the plasma. The problem of alpha-particle losses in a magnetic configuration having a loss-cone and non-zero alpha Larmor radius is treated. First, an exact analytic solution is found for the zero-dimensional, time-dependent Fokker-Planck equation with a constant plasma reactivity switched on abruptly in time. Several effects are accounted for, including alpha endloss, finite alpha Larmor radius size (compared to the plasma radius), and alpha pitch-angle scattering. The results of the exact solution are then used as a guide in constructing a mocked-up representation of alpha behaviour. This model, based on two coupled first-order time-differential equations, accounts for all the effects contained in the more complicated exact solution; in addition, it allows arbitrary time variation in plasma parameters and reactivity.

28163 **Radial confinement of central cell plasma in tandem mirrors.** Lao, L.L. Madison, WI; Univ. of Wisconsin (1979). 178p. University Microfilms Order No. 80-01,155.

Thesis (Ph. D.).

The single particle guiding center orbit analysis is carried out both numerically and analytically. The guiding center orbit can be characterized by the amount of the azimuthal drift, $\Delta\theta$, of a particle in one bounce through the central cell. It is demonstrated numerically using the magnetic field geometry and plasma parameters of the Wisconsin tandem device PHAEDRUS,, that if $\Delta\theta << 1$, the particle drift surfaces are circular when the flux tubes in the plugs are joined orthogonally to each other. The radial losses of particle and energy are studied in the fluid approximation. A set of transport equations are obtained by assuming the magnetic field in the three mirror cells to be square wells. The radial and axial losses of particle and energy and the interaction of the electron fluid with various ionic species are properly taken into account.

28164 **Laser-plasma interaction in a theta-pinch geometry.** Armstrong, W.T. Boulder, CO; Univ. of Colorado (1978). 170p. University Microfilms Order No. 78-20,483.

Thesis (Ph. D.).

Prompt stimulated Brillouin scatter (SBS) is studied in an experiment wherein a high power, pulsed CO_2 laser irradiates an independently produced, theta-pinch plasma. SBS does not significantly affect laser heating of the plasma. Measurements of density profiles and temperature, local heating histories permitted examination of laser refraction, local heating and net absorption. Refractive containment of the CO_2 laser beam by an on-axis density minimum was observed at early times during the laser pulse. However, refractive containment was lost at late times due to the diffusive loss of the density minimum. Classical modeling of the expected heating required bleached absorption to account for the observed heating. A plasma absorptivity of ~ 46% was inferred from calorimetry measurements at 250 mtorr fill pressure. These results confirm that classical heating and refraction dominated the laser-plasma interaction.

28165 **Ray tracing analysis of fast wave heating of tokamaks.** McVey, B.D. Madison, WI; Univ. of Wisconsin (1978). 159p. University Microfilms Order No. 78-15,058.

Thesis (Ph. D.).

It appears that a supplementary heating scheme will be required to elevate the temperature of a tokamak plasma to ignition conditions. One such scheme utilizes radio frequency (R.F.) heating via the fast wave in the ion cyclotron range of frequencies (ICRF). The ultimate usefulness of fast wave heating is dependent upon the scaling to reactor tokamaks. We analyze here some aspects of this scaling picture.

28166 **Electrostatic confinement of a laser produced plasma.** Mussetto, M.S. New Haven, CT; Yale Univ. (1978). 119p. University Microfilms Order No. 78-20,167.

Thesis (Ph. D.).

This thesis presents an experiment in electrostatic confinement in which a large electron flux is discharged into an expanding laser produced plasma. This results in space charge overcompensation and electrostatic inhibition to the escape of the laser produced ions from the discharge. The laser produced plasma was created by focussing a submicrosecond 10.6 micron radiation pulse from a CO_2 laser onto a carbon target in vacuum which also served as a cathode for the discharge. The plasma consisted of more than 10^{16} ions with initial energies typically 100 eV. Discharge currents resulting in the confinement were studied in the range up to 300 amps, with corresponding discharge running voltages up to ~150 volts. Electrostatic inhibition to ion escape is accomplished by the establishment of self-consistent electric fields in the discharge and a collisionless sheath at the discharge anode (the grounded walls of the vacuum system in which the discharge occurs). The mechanisms that play a role in the confinement are examined in a variety of idealized models.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 28218

28167 (UCRL—52940) **Rutherford scattering of neutral atoms: a technique for measuring plasma ion temperatures. An analysis of the applicability to the central cell plasma of TMX.** Granneman, E.H.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Jun 1980. Contract W-7405-ENG-48. 38p. NTIS, PC A03/MF A01.

Rutherford scattering of neutral particles by plasma ions is examined as a method for determining plasma ion in the central cell

fo the Tandem Mirror Experiment (TMX). When a scattering configuration, consisting of a 20-keV-, 10-A-deuterium neutral beam and an energy analyzer with a 1% resolution, is arranged such that only neutral particles scattered by plasma ions over an angle of 10^9 are accepted, central-cell ion temperatures in the 30- to 1000-eV range can be measured. The count rate registered by the detector(s) is estimated to be 2000 counts/ms. Consequently, good statistical accuracy and time resolution are attainable simultaneously. The results of the calculation are presented such that the scaling of the count rates and the energy broadening with scattering angle, neutral-beam energy, ion temperature, and plasma density can easily be deduced. Neutral helium beams are also considered; they have some advantages over deuterium beams. The background signal, caused by neutral particles entering the detector after two successive charge-exchange collisions, is examined and ways to completely eliminate this background are indicated.

PLASMA KINETICS - GENERAL

28168 (LA-UR—80-1875) **Transient phenomena on ZT-40.** Jacobson, A.R.; Buchenauer, C.J. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 6p. (CONF-800484—2). NTIS, PC A02/MF A01.

From Reversed field pinch theory workshop; Los Alamos, NM, USA (28 Apr 1980).

Two aspects of fluctuations in the ZT-40 reversed-field pinch are examined. First, the polarization of the magnetic fluctuations in the outer (vacuum) region is discussed. This in turn provides information on the wavevectors associated with the turbulence. The results provide some clues about the location (in minor radius) of the singular surfaces which are customarily associated with fluctuations. Second, the density fluctuations are studied using a multichord interferometer. The spatial distribution (in major radius) of the chord-averaged fluctuations are also described.

PLASMA KINETICS - EXPERIMENTAL

28169 (CONF-800455—13) **Initial measurement of impurity production and hydrogen energy distribution from neutral beam injectors.** Langley, R.A.; Magee, C.W. (Oak Ridge National Lab., TN (USA); RCA Labs., Princeton, NJ (USA)). 1980. Contract W-7405-ENG-26. 20p. NTIS, PC A02/MF A01.

From 4. international conference on plasma surface interactions in controlled fusion devices; Garmisch, F.R. Germany (21 Apr 1980).

Impurity production and hydrogen energy distributions for neutral beam injectors (NBI) developed by the plasma Technology Section of Oak Ridge National Laboratory's (ORNL's) Fusion Energy Division have been measured by exposing silicon samples to beam pulses and analyzing them by nuclear microanalysis and secondary ion mass spectrometry (SIMS) techniques. The NBI's have been developed for use on the princeton Large Torus (PLT), the Poloidal Divertor Experiment (PDX), and the Impurity Study Experiment (ISX). Extraction voltages O up to 50 kV are used, and maximum power injected for a 0.5-s pulse is ~ 1.2 MW with a design goal of 1.5 MW. The Medium Energy Test Facility (MRTF) was used for exposure of the single-crystal [100] silicon samples.

28170 (SAND—80-1180C) **Deuterium ion fluxes to probes in the PLT edge plasma.** Cohen, S.A.; Dylla, H.F.; Wampler, W.R.; Magee, C.W. (Princeton Univ., NJ (USA). Plasma Physics Lab.; Sandia Labs., Albuquerque, NM (USA); RCA Labs., Princeton, NJ (USA)). 1980. Contract AC04-76DP00789. 19p. (CONF-800455—14). NTIS, PC A02/MF A01.

From 4. international conference on plasma surface interactions in controlled fusion devices; Garmisch, F.R. Germany (21 Apr 1980).

Using secondary ion mass spectrometry and nuclear reaction analysis, we have measured deuterium trapped in carbon samples exposed to deuterium discharges in PLT. From these data we infer that the fluxes range from 2×10^{15} to 3×10^{17} $cm^{-2}s^{-1}$, and the energies range from 60 to 225 eV. Studies have been made on the effect of gas puffing and plasma position.

28171 **Evaluations of the electron energy distribution in multidipole plasmas.** Taylor, G.R.; Kessel, M.A.; Sealock, J.W. (James Madison Univ., Harrisonburg, VA). *James Madison J.*; **38**: 5-24(1980).

In a previous paper a preliminary evaluation of the electron energy distribution in multidipole plasmas was presented. A polynominal regression technique for evaluating the distribution function from Langmuir probe current-voltage characteristics was described. This paper presents an extension of that analysis and the evaluations of the electron energy distributions in multidipole argon and hydrogen plasmas.

28172 **EUV emissions and grad B-drift transport in tokamak discharges.** Terry, J.L. II. Baltimore, MD; Johns Hopkins University (1979). 191p. University Microfilms Order No. 79-06,490.

Thesis (Ph. D.).

Spectrophotometric measurements of extreme ultraviolet line radiation emitted from tokamak plasmas were made. The recently constructed, 0.4 m monochromator used for the measurements was also used to spatially resolve emissions from OVI, OV, and NV, common impurity ions. Both the monochromator and the technique by which the emissions were spatially resolved are described in detail.

28173 **Turbulence measurements by digital spectral estimation in the ohmically heated Proto-Cleo Torsatron.** Casper, T.A. Madison, WI; Univ. of Wisconsin (1979). 185p. University Microfilms Order No. 79-19,791.

Thesis (Ph. D.).

Low frequency fluctuations have been observed in the ohmically heated plasma of the Proto-Cleo Torsatron. Density fluctuations inferred by ion saturation current of double Langmuir probes were Fourier analysed using digital signal processing techniques. Results indicate the fluctuations to be of a turbulent nature with no narrow-band coherent phenomena observed for frequencies less than 500 kHz. The power density spectra indicate a decay of power with frequency for index n, ω/sup -n/, in the range 2.3. ≦ n ≦ 2.6. The phase spectral characteristics observed produce wave number estimates consistent with a model for drift waves perpendicular to the toroidal magnetic field. The phase spectra indicate that these are coupled to the parallel direction proportional to the magnetic field shear as a funtion of minor radius. Spatially separated probe signals remain moderately coherent to frequencies up to 350 kHz with maximum coherence in a region near r = 2.5 cm (minor radius), the region of maximum density gradient inside the confinement region for this device. The fluctuation level in the observed band of frequencies is of relatively low level with n tilde n ≅ 5%. The fluctuations are believed to be driven by the ohmic heating current and result in diffusion coefficient estimates consistent with fluctuation induced E tilde x anti B diffusion.

28174 **Convective cells and their relationship to vortex diffusion in the Wisconsin levitated octupole.** Ehrhardt, A.B. Madison, WI; Univ. of Wisconsin (1978). 210p. University Microfilms Order No. 79-18,886.

Thesis (Ph. D.).

Non-azimuthally symmetric floating potential structure (also called vortices or convective cells) was examined to determine whether the structure is responsible for enhanced diffusion in the Octupole. Two gun plasmas were used: a collisionless H plasma (n_o ~ 5×10^9 cm^{-3}, T/sub io/ ~ 30 eV); and a collisional He plasma (n_o ~ 2×10^{11} cm^{-3}, T/sub i,e/ ~ .2eV). The floating potential was measured as a function of the coordinates perpendicular to the magnetic field by a Langmuir probe mounted on a cart which could be moved azimuthally along the bottom of the Octupole; the results are presented as two-dimensional contour plots. For a purely poloidal field, the floating potential was found to be constant along a magnetic field line, and the two-dimensional contours can be rotated about one of the internal rings to show the three-dimensional potential structure.

28175 **Experimental investigation of current driven turbulence in a low density torus.** Richardson, R.D. Austin, TX; Univ. of Texas (1978). 224p. University Microfilms Order No. 79-00,622.

Thesis (Ph. D.).

A toroidal confinement device of 68 cm major radius, 4 cm minor radius and one kilogauss magnetic field is used to study current driven turbulence in low density hydrogen, helium, argon, and krypton plasmas. The steady state initial plasma is subjected to step-function toroidal electric fields of 1 to 100 volts/cm, which are much greater than the classical electron runaway field of 10^{-2} volts/cm. Electrons freely accelerate up to ten times their initial thermal velocity until collective instabilities set in producing a state of anomalous resistivity. Resistivities of several ohm cm (more than two orders of magnitude above classical), which remain reasonably constant during the 1 microsec. pulse, are measured. The turbulently heated electron velocity distributions are measured with an E x B particle analyzer. Heating rates of 100 keV/microsec. and temperatures of 10 keV are recorded. The distributions exhibit several strong beam-like structures which persist throughout the entire pulse. Preliminary measurements of the fluctuation spectra using double electric probes reveal a broad and complex spectrum with peaks at ω/sub pe/ and ω/sub pe//2.

PLASMA KINETICS - THEORETICAL

REFER ALSO TO CITATION(S) 28159, 28163, 28190

28176 (CONF-800551—4) **Development and applications of multi-step Hauser-Feshbach/pre-equilibrium model theory.** Fu, C.Y. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 14p. NTIS. PC A02/MF A01

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

A recently developed model that combines compound and precompound reactions with conservation of angular momentum is discussed. This model allows a consistent description of intermediate excitations from which tertiary reaction cross sections can be calculated for transitions to the continuum as well as to the discrete residual levels with known spins and parities. Predicted neutron, proton, and alpha-particle production cross sections and emission spectra from 14-MeV neutron-induced reactions are compared favorably with angle-integrated experimental data for 12 nuclides. The model is further developed to include angular distributions of outgoing particles. The random phase approximation used for the compound stage is partially removed for the precompound stages, allowing off-diagonal terms of the collision matrix to produce both odd and even terms in the Legendre polynomial expansion for the angular distribution. Calculated double differential cross sections for the 14.6-MeV $^{23}Na(n,n'x)$ reaction are compared with experimental data.

28177 (NRL-MR—4252) **MHD plasma channel response to propagating ion beams.** Colombant, D.G.; Goldstein, S.A.; Mosher, D. (Naval Research Lab., Washington, DC (USA)). 24 Jun 1980. Contract AI01-76ET28382. 14p. NTIS, PC A02/MF A01.

Hydrodynamic response of plasma channels induced by intense propagating ion beams is examined using both analytical estimates and a one-dimensional radial numerical model. It is found that mega-ampere, 3-5 MeV proton beams can be propagated in deuterium background over several meters.

28178 (ORNL/CSD/TM—119) **ETFOD: a point model physics code with arbitrary input.** Rothe, K.E.; Attenberger, S.E. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 77p. NTIS, PC A05/MF A01.

ETFOD is a zero-dimensional code which solves a set of physics equations by minimization. The technique used is different than normally used, in that the input is arbitrary. The user is supplied with a set of variables from which he specifies which variables are input (unchanging). The remaining variables become the output. Presently the code is being used for ETF reactor design studies. The code was written in a manner to allow easy modificaton of equations, variables, and physics calculations. The solution technique is presented along with hints for using the code.

28179 (UCID—18710) **Fusion product deposition and energy balance.** Condit, W.C.; Driemeyer, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.; Illinois Univ., Urbana (USA)). 20 May 1980. Contract W-7405-ENG-48. 8p. NTIS, PC A02/MF A01.

Extensive Monte-Carlo calculations were performed of alpha-particle deposition in the Hill's Vortex configuration, as reported in D.E. Driemeyer's Ph.D. Thesis (University of Illinois, 1980). This has generally been done including a cold plasma density, n/sub c/, on the open field lines, with n/sub C//T/sub C//sup 3/2/ ≃ n/sub H//T/sub H//sup 3/2/ - i.e. with the slowing down ratio tau/sub H//tau/sub C/ lying between .1 and 10. Since many of the alpha particles spend a significant amount of their time on the open field lines, values of tau/sub H//tau/sub C/ greater than unity lead to significant removal of alpha-particle ash from the closed-field region. Surprisingly, one is able to perform this ash removal and still retain enough energy to raise the reactor Q significantly (or even ignite it).

28180 Impurity transport in tokamak plasmas containing momentum sources. Parks, P.B.; Burrell, K.H.; Wong, S.K. (General Atomic Co., San Diego, CA (USA)). *Nucl. Fusion;* **20**: No. 1, 27-34(Jan 1980).

Impurity transport in a tokamak plasma in the presence of an externally imposed momentum source is considered. Including a model collision term to damp toroidal angular momentum and imposing the conventional ambipolar transport condition, the authors obtain expressions demonstrating that properly chosen momentum sources (e.g. radio-frequency fields) can cause outward the impurity transport. Estimates of the RF source strength needed to stop inward impurity diffusion show that the power absorbed by the plasma is small.

28181 Analysis of the time integration in plasma simulation. Langdon, A.B. (Univ. of California, Livermore). *J. Comput. Phys.;* **30**: No. 2, 202-221(Feb 1979).

This paper treats the collective behavior of hot plasma as modified by the numerical time integration methods used to integrate the particle equations of motion in computer simulation of plasmas. No approximation, other than ignoring roundoff errors, is made in analyzing the finie-difference algorithms. Our results reduce simply and exactly to the corresponding results of plasma theory in the limit $\Delta t \rightarrow 0$. The possibility of nonphysical instability is considered. The results of this and of previous papers are combined to describe both the spatial and temporal difference algorithms. The theory is generalized to a class of integration schemes, some algorithms are analyzed, and a new example is synthesized. The difficulty of developing algorithms stable at very large time steps is examined. The present analysis may be combined with an earlier rigorous analysis of the spatial grid used for field equations, to develop a kinetic theory of simulation plasmas paralleling that for real plasmas. This theory may be of use in the design and interpretation of computer simulation experiments.

28182 Two-dimensional simulation of a plasma in a periodic picket fence. Marcus, A.J. Iowa City, IA; Univ. of Iowa (1979). 110p. University Microfilms Order No. 79-24,501.

Thesis (Ph. D.).

A two-dimensional particle-in-cell (PIC) simulation of a periodic picket fence is described and used to study plasma behavior and confinement. A Lagrangian formulation which includes the invariance of the z-component of the generalized momentum is written as a time symmetric difference scheme in the electrostatic approximation. The results include the following features. The plasma settles into a steady state after a transient period. Positive charge peaks are formed in front of the fence conductors. The potential develops a monotonically decreasing channel of the order of 0.5 T/sub e//e in the cusp. The half-width of the leak in the cusp through which the ions escape is significantly smaller than the ion gyroradius.

28183 Renormalized plasma kinetic theory-general structure and relaxation properties. Terry, R.E. Baltimore, MD; Johns Hopkins University (1979). 264p. University Microfilms Order No. 79-06,500.

Thesis (Ph. D.).

Standard practice in nonequilibrium statistical mechanics neglects initial distribution functions in kinetic theories and models turbulence with ad hoc stochastic fields. Here a plasma kinetic theory is developed which provides a statistical description of plasma turbulence by rigorously incorporating the initial distribution functions into an extended statistical mechanics.

28184 Three dimensional electromagnetic particle simulation of fusion plasmas. Nielsen, D.E. Jr. Stanford, CA; Stanford University (1979). 215p. University Microfilms Order No. 79-17,265.

Thesis (Ph. D.).

The research to be reported here is an effort to implement a three dimensional, relativistic and fully electromagnetic particle simulation and non-uniform plasmas. As many have pointed out, the primary obstacles to 3D particle simulations are not of an algorithmic nature, but are rather problems of limited computing resources: speed, memory size and data management. By a careful choice of algorithms and extensive optimization in the programming and data management, a workable, efficient, and yet easy to use set of programs have been developed for physics simulations. The principal physical system studied has been the case of neutral beam injection into a plasma which has been confined by a typical mirror magnetic field.

28185 Computer simulation of beam-plasma interaction. Goldstein, B.M. Hoboken, NJ; Stevens Inst. of Tech. (1978). 145p. University Microfilms Order No. 78-21,619.

Thesis (Ph. D.).

The generation of harmonics is studied in the magnetized plasma. If a wave is excited near the constant phase velocity portion of the dispersion relation of the ambient plasma its harmonic grows to sufficient amplitude to destroy the trapped particle oscillations of the initial wave. These results are verified by the technique of numerical simulation of plasmas.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 28185

28186 (CONF-800456—2) **Electrostatic toroidal drift mode turbulence in tokamaks.** Hirshman, S.P.; Diamond, P.H.; Rosenbluth, M.N.; Chen, L.; Molvig, K.; Whitson, J.C.; Smith, J. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 12p. NTIS, PC A02/MF A01.

From Sherwood theory meeting; Tucson, AZ, USA (23 Apr 1980).

The kinetic theory of turbulent effects due to electron orbit stochasticity was combined with linear response in toroidal geometry. A review of the linear theory is given. The toroidal electron response is given in the ballooning representation. (MOW)

28187 Plasma self-heating and saturation due to numerical instabilities. Birdsall, C.K.; Maron, N. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). W-7405-ENG-48;EY-76-S-03-0034-PA128. *J. Comput. Phys.;* **36**: No. 1, 1-19(Jun 1980).

The cold-beam nonphysical instability due to the aliases produced by the numerical spatial grid is presented in detail for momentum-conserving linear weighting codes. Additions to previous work include: linear analysis dispersion diagrams showing large growth rates, ω/sub i/< or =0.2 ω/sub p/; methods for reducing ω/sub i/,

effectively broadening the finite-size particle width; simulation results verifying the linear theory, plus plots showing the p=1 alias in phase space (v/sub x/, x); the growth of beam, thermal spread (v/sub t/^{2} in temperature) an loss of energy conservation; end-of-growth (saturation at small thermal spread (λ/sub D//Δx=v/sub t//ω/sub p/Δx≈0.046, for λ/sub B//Δxequivalent v_0/ω/sub p/Δx> or =0.3, i.e., v/sub t/< or =0.14v_0), with return to near energy conservation (stability); demonstration of no growth for a warm beam, with v/sub t/(initial)> or =v/sub t/(saturation); and the mechanism of stabilization (trapping). A thermal (Maxwellian) plasma, also nonphysically unstable at small λ/sub D//Δx, is also found to approach stabilization by self-heating. The two-stream physical instability is affected by the grid, with the aliasing instability also present; the linear theory for this is presented, with guidelines for minimizing the effects of the grid.

28188 (UCRL-Trans—11593) **Electromagnetic instabilities in collisionless plasmas.** Laval, G.; Pellat, R.; Vuillemin, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1980. Translation of CN—21/71, pp 259-276. 38p. NTIS, PC A03/MF A01.

The stability of inhomogeneous collisionless plasmas with respect to electromagnetic perturbations is studied. The macroscopic equilibrium parameters depend on a single coordinate of an orthogonal system. The current carried by the particles of the plasma is directed along another coordinate axis. The perturbations considered are constant along the current lines. In plane geometry, for example, the distribution functions of the particles depend only on the energy and on the moment along 0Z of the Hamiltonian of a particle. The equilibrium is inhomogeneous along 0X and the perturbations are invariant with respect to 0Z. A Lyapunov function is constructed.

28189 Electrostatic drift waves in tokamaks. A numerical study of instability and transport. Waltz, R.E.; Pfeiffer, W.; Dominguez, R.R. (General Atomic Co., San Diego, CA (USA)). *Nucl. Fusion;* **20**: No. 1, 43-57(Jan 1980).

A numerical study of drift modes in the electrostatic slab approximation over a range of parameters consistent with Ohmically heated tokamaks is described. With this model it is found that the trapped-electron mode may be excited only at low collisionality (nu^*sub(min)<1), whereas for moderate to high collisionality (1<nu^*sub(min)<10), where many tokamaks have anomalous transport, the mode is shear-stabilized. The current-driven, resonant-electron mode is strongly stabilized for practical current drifts. The ion-temperature-gradient mode is unstable for d ln Tsub(i)/d ln n>1 at all collisionalities. From the electrostatic quasi-linear theory of transport, it is found that the electron modes (except near marginal stability) and the ion mode have ion thermal conductivity comparable to or larger than the electron thermal conductivity, in contrast to experimental results. It is concluded that the quasi-linear, electrostatic slab model of drift waves does not adequately describe anomalous transport in tokamaks.

28190 Tensor pressure tokamak equilibrium and stability. Cooper, A. Ann Arbor, MI; Univ. of Michigan (1979). 222p. University Microfilms Order No. 80-07,723.

Thesis (Ph. D.).

The equilibrium and MHD stability of tokamaks with tensor pressure are examined. The effects of anisotropies induced by neutral beam injections are studied. Perpendicular and parallel beam pressure components are evaluated by taking moments of a distribution function obtained from the solution of a Fokker-Planck equation that models the injection of high energy neutral beams into a tokamak. We numerically generate D-shaped beam-induced tensor pressure equilibria and find that the level perpendicular-pressure contours can be quite distorted and shifted away from the outer boundary (compared to the flux surfaces), especially with perpendicular injection into broad pressure profile equilibria; the level parallel-pressure contours undergo a smaller shift which is concentrated in the central core of the plasma. On the other hand, in equilibria with peaked pressure profiles, the pressure contours nearly coincide with the flux surfaces. A force balance relation, a representation for the poloidal beta (β/sub p/), and expressions for the current densities are derived, in addition, from the MHD equilibrium relations for an axisymmetric tensor pressure tokamak.

28191 Steady-state and time-dependent behavior of fusion-fission hybrid systems. Vernetson, W.G. Gainesville, FL; Univ. of Florida (1979). 445p. University Microfilms Order No. 80-02,909.

Thesis (Ph. D.).

This study examined stability analysis of point-model systems representing pure fusioning plasmas as well as coupled fusion-fission systems. The stability criteria for these systems were derived for constant plasma confinement conditions based on engineering perturbations of the system feedrate. The results of linearized point-model plasma stability analysis of the thermal instability were shown to be applicable to hybrid plasmas and to be attainable from considerations of engineering-related perturbations in the extrinsic plasma feedrate variable. A Tokamak fusion-fission hybrid design was selected for further, more specific analysis. The modeled hybrid system in linearized form was found to be stable provided certain hybrid plasma temperature and confinement time limits are met. However, for realistic installations, absolute stability is not sufficient; nor is it guaranteed by linearized analysis. Therefore, hybrid plasma behavior was examined under transient and overpower conditions.

28192 Effect of cold plasma on the Kelvin-Helmholtz instability. Melander, B.G. Seattle, WA; Univ. of Washington (1978). 137p. University Microfilms Order No. 79-20,747.

Thesis (Ph. D.).

The thesis studies the effect of a two-component plasma (hot and cold) on the shear driven Kelvin-Helmholtz instability. An ion distribution with a shear flow parallel to the ambient magnetic field and a density gradient parallel to the shear direction is used. Both the electrostatic and electromagnetic versions of the instability are studied in the limit of hydromagnetic frequencies. The dispersion relation is obtained in the electrostatic case by solving the Vlasov equation for the perturbed ion and electron densities and then using the quasineutrality condition. In the electromagnetic case the coupled Vlasov and Maxwell's equations are solved to obtain the dispersion relation.

PLASMA WAVE PHENOMENA

28193 (UCRL—83517) **Nonlinear ion-cyclotron waves in mirror machines. Paper IAEA-CN-38/S-1.** Cohen, B.I.; Smith, G.R.; Berk, H.L. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). 22 May 1980. Contract W-7405-ENG-48. 13p. (CONF-800707—4). NTIS, PC A02/MF A01.

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Experimental results on ion-cyclotron waves observed in the 2XIIB mirror machine are reviewed, and relevant theoretical work is discussed. The work reported generally substantiates the quasilinear diffusion model of mirror-plasma confinement, but also suggests alternatives. The end-loss current required by theory of the drift-cyclotron loss-cone (DCLC) instability agrees with measurements of this current. The experiment indicates that an increased ratio of plasma radius to ion gyroradius improves plasma confinement. However, measurements sometimes show a second ion-cyclotron mode, which is not the DCLC mode. Theoretical work on loss-cone instabilities has concentrated on linear, quasilinear, and fully nonlinear models of increased sophistication and experimental applicability.

FUSION POWER PLANT TECHNOLOGY

28194 (COO—2218-162) **CTR plasma engineering studies. Annual progress report, 1 October 1979—30 September 1080.** Miley, G.H. (Illinois Univ., Urbana (USA). Fusion Studies Lab.). 1980. Contract AS02-76ET52040. 62p. NTIS, PC A04/MF A01.

FY 1980 CTR Plasma Engineering Studies performed at the University of Illinois are reported. Current studies concentrated on four major areas including (i) field-reversed mirror (FRM) and related compact tori, (ii) dynamic behavior of the reversed-field pinch (RFP) including transport and stability and start-up, (iii) plasma buildup in small mirrors by including finite, ion orbit effects as well as the drift cyclotron loss-cone velocity-space diffusion, and (iv) high-energy fusion product transport in non-circular and high-β tokamaks, alpha ash buildup and possible control in tokamaks. Various computer packages have been produced for FRM, FROP, RFP, small compact tori and non-circular tokamaks. Basic models and the code packages developed and tested with available experiments are of vital information that can be used in conceptual reactor studies for the scaling and prediction of plasma behavior in near-term reactors.

28195 (LA-UR—80-1494) **Reversed-field pinch fusion reactor.** Hagenson, R.L.; Krakowski, R.A. (Science Applications, Inc., Ames, IA (USA); Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 14p. (CONF-800806—4). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

A conceptual engineering design of a fusion reactor based on plasma confinement in a toroidal Reversed-Field Pinch (RFP) configuration is described. The plasma is ohmically ignited by toroidal plasma currents which also inherently provide the confining magnetic fields in a toroidal chamber having major and minor radii of 12.7 and 1.5 m, respectively. The DT plasma ignites in 2 to 3 s and undergoes a transient, unrefueled burn at 10 to 20 keV for ~ 20 s to give a DT burnup of ~ 50%. The 5-s dwell period between burn pulses for plasma quench and refueling allows steady-state operation of all thermal systems outside the first wall; no auxiliary thermal capacity is required. Tritium breeding occurs in a granular Li_2O blanket which is packed around an array of radially oriented water/steam coolant tubes. The slightly superheated steam emerging from this blanket directly drives a turbine that produces electrical power

at an efficiency of 30%. A borated-water shield is located immediately outside the thermal blanket to protect the superconducting magnet coils. Both the superconducting poloidal and toroidal field coils are energized by homopolar motor/generators. Accounting for all major energy sinks yields a cost-optimized system with a recirculating power fraction of 0.17; the power output is 750 MWe(net).

28196 (ORNL/TM—7278) **Large Aspect Ratio Tokamak Study.** Reid, R.L.; Holmes, J.A.; Houlberg, W.A.; Peng, Y.K.M.; Strickler, D.J.; Brown, T.G.; Wiseman, G.W. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 57p. NTIS, PC A04/MF A01.

The Large Aspect Ratio Tokamak Study (LARTS) at Oak Ridge National Laboratory (ORNL) investigated the potential for producing a viable longburn tokamak reactor by enhancing the volt-second capability of the ohmic heating transformer through the use of high aspect ratio designs. The plasma physics, engineering, and economic implications of high aspect ratio tokamaks were assessed in the context of extended burn operation. Using a one-dimensional transport code plasma startup and burn parameters were addressed. The pulsed electrical power requirements for the poloidal field system, which have a major impact on reactor economics, were minimized by optimizing the startup and shutdown portions of the tokamak cycle. A representative large aspect ratio tokamak with an aspect ratio of 8 was found to achieve a burn time of 3.5 h at capital cost only ~ 25% greater than that of a moderate aspect ratio design tokamak.

28197 (UCRL—15245(Vol.1)) **Tandem mirror hybrid reactor study (LLL Purchase Order 6887809 dated August 31, 1979).** (Bechtel National, Inc., San Francisco, CA (USA)). Feb 1980. Contract W-7405-ENG-48. 20p. NTIS, PC A02/MF A01.

The results, bases, qualifications, and exclusions of the preconceptual cost estimate are presented below. This estimate is an order-of-magnitude assessment of the direct level POP Costs. The direct level cost consists of: (1) total cost of all materials forming the permanent part of the completed plant, and (2) total cost of all labor engaged in installing and erecting all materials forming the permanent part of the completed plant. A cost summary and a supporting breakdown of this estimate are shown.

28198 (UCRL—15245(Vol.2)) **Tandem mirror hybrid reactor study (LLL Purchase Order 3323609 dated October 20, 1978).** (Bechtel National, Inc., San Francisco, CA (USA)). Feb 1980. Contract W-7405-ENG-48. 89p. NTIS, PC A05/MF A01.

In any nuclear power plant, reactor design and performance are the major determining and driving factors of the plant economic and technical viability. However, the balance-of-plant (BOP) - which includes heat transport and energy conversion systems, plant auxiliary systems, plant electrical system, and structures and facilities - has a major effect on the plant economics. In fact, the BOP can account for as much as 70 to 85 percent of the total plant capital cost and therefore will have a significant impact upon the economic viability of the plant. Further, decisions made in the reactor design can have significant impact on the BOP design. A preconceptual BOP design and an order-of-magnitude cost estimate were developed for the helium cooled TMHR and are described.

28199 **Perspective on the fusion-fission energy concept.** Liikala, R.C.; Perry, R.T.; Teofilo, V.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). *Arch. Energiewirtsch.;* **33**: No. 9, 734-750(Sep 1979). (In German).

In this report, the basic characteristics of the pure fusion and the hybrid concepts are briefly explained, together with possible ways of incorporating plants of this reactor type into the existing energy scene. Furthermore, the advantages offered by hybrid reactors with regard to costs and operating behaviour in comparison with hitherto existing electricity generating systems are outlined. The problems currently discussed in connection with nuclear fission technology and the non-proliferation of nuclear weapons are also mentioned. As far as the fission process is concerned, the development of hybrid reactors has to be linked with the non-proliferation scene. Basic requirements to be met by hybrid reactor systems in the near future are defined.

BLANKET ENGINEERING

28200 (ANL/FPP—79-1) **Fusion reactor blanket/shield design study.** Smith, D.L.; Clemmer, R.G.; Harkness, S.D. (Argonne National Lab., IL (USA); McDonnell Douglas Astronautics Co., St. Louis, MO (USA)). Jul 1979. Contract W-31-109-ENG-38. 426p. NTIS, PC A19/MF A01.

A joint study of tokamak reactor first-wall/blanket/shield technology was conducted by Argonne National Laboratory (ANL) and McDonnell Douglas Astronautics Company (MDAC). The objectives of this program were the identification of key technological limitations for various tritium-breeding-blanket design concepts, establishment of a basis for assessment and comparison of the design features of each concept, and development of optimized blanket designs. The approach used involved a review of previously proposed blanket designs, analysis of critical technological problems and design features associated with each of the blanket concepts, and a detailed evaluation of the most tractable design concepts. Tritium-breeding-blanket concepts were evaluated according to the proposed coolant. The ANL effort concentrated on evaluation of lithium- and water-cooled blanket designs while the MDAC effort focused on helium- and molten salt-cooled designs. A joint effort was undertaken to provide a consistent set of materials property data used for analysis of all blanket concepts. Generalized nuclear analysis of the tritium breeding performance, an analysis of tritium breeding requirements, and a first-wall stress analysis were conducted as part of the study. The impact of coolant selection on the mechanical design of a tokamak reactor was evaluated. Reference blanket designs utilizing the four candidate coolants are presented.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 28242

28201 (LA—8375-PR) **Tokamak poloidal field systems. Progress report, January 1-December 31, 1979.** Rogers, J.D. (comp.). (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 15p. NTIS, PC A02/MF A01.

Work is reported on the development of superconducting tokamak poloidal field systems (TPFS). Progress is discussed on the design of a 20 MJ, 50 kA, 7.5 T superconducting pulsed energy storage coil operated in a 1 to 2 s bipolar mode from +7.5 T to -7.5 T in 1982. Conductor development for the coil is presented. A facility that uses a traction motor energy transfer system to test coils in the 20 to 100 MJ energy range is discussed. Current interrupter development and testing for protection and energy transfer circuits are also presented. The 400 kJ METS coil test preparation is under way.

28202 (UCRL—83518) **Theory of field-reversed mirrors and field-reversed plasma-gun experiments. Paper IAEA-CN-38/R-2.** Anderson, D.V.; Auerbach, S.P.; Berk, H.L. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). 22 May 1980. Contract W-7405-ENG-48. 18p. (CONF-800707—6). NTIS, PC A02/MF A01.

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Experimental and theoretical studies of field reversal in a mirror machine are reported. Plasma-gun experiments demonstrate that reversed-field plasma layers are formed. Low energy plasma flowing behind the initially produced plasma front prevents tearing of the layer from the gun muzzle. MHD simulation shows that tearing can be obtained by impeding the slow plasma flow with a plasma divider. It is demonstrated theoretically that a field-reversed mirror imbedded in a multipole field can be sustained in steady state with neutral-beam injection even in the absence of impurities. MHD stability analysis shows that growth rates of elongated reversed-field θ-pinch configurations decrease with axial extension, which indicates the importance of including finite Larmor radius in the analysis. Tilting-mode criteria are dramatically improved by proper shaping, and a problimak shape is proposed. Tearing mode stability of reversed-field θ-pinches is greatly enhanced by flux exclusion. Self-consistent, 1-1/2-dimensional transport codes have been developed, and initial results are presented.

28203 **Perturbed magnetic-field phase slip for tokamaks.** Vahala, G.; Vahala, L. (College of William and Mary, Williamsburg, VA (USA). Dept. of Physics); Harris, J.H.; Bateman, G.; Waddell, B.V.; Dunlap, J.L.; Pare, V.K.; Burris, R.D. . *Nucl. Fusion;* **20**: No. 1, 17-26(Jan 1980).

Given a set of rotating helical current filaments within a cylindrical plasma and a set of fixed magnetic-field detectors at the edge of the plasma, a mathematical model is used to investigate the observable effect of rotation or longitudinal motion in the intervening plasma. If the soft-X-ray signals from magnetic islands indicate the instantaneous position of the helical current filaments within the plasma, then the phase difference between the X-ray signal and the magnetic fluctuations should provide a diagnostic of tokamak plasma rotation. The relative motion between the islands and the electron fluid is measured by the 'slip' S(r)=ω - kvsub(z)(r) - mvsub(theta)(r)/r, where ω is the rotation frequency of the islands and v vector is the electron fluid velocity. - The plasma velocity and the Hall effect are added to Rosenbluth's reduced equations to compute the phase difference between the island position and the perturbed magnetic field at the edge of the plasma as a function of the slip for a variety of resistivity profiles. The current profile within the islands is taken from the non-linear computer results of White, Monticello, Rosenbluth and Waddell. - Comparison with experiment indicates essentially locked electron fluid and mode motions, i.e. S(r) approximately equal to 0.

POWER SUPPLIES, ENERGY STORAGE

28204 (GA-A—15903) **8MVA modulator/regulator for neutral beams.** Remsen, D.B. Jr.; Overett, T.H. (General Atomic Co., San Diego, CA (USA)). May 1980. Contract AT03-76-ET-51018. 7p. (CONF-800640—3). NTIS, PC A02/MF A01.

From 14. pulse power modulator symposium; Orlando, FL, USA (3 Jun 1980).

This paper describes very generally the modulator/regulator (Mod/Reg) being built for Transrex by Systems, Science and Software for use on the neutral beam power supplies that Transrex is building for General Atomic Company to power the neutral beam heating systems that will be used on the Doublet III fusion device. The Mod/Reg is required to provide an 80 kV, 100 A pulse for a second every 90 sec. The voltage is to be regulated to 3%, and in case of fault the pulse must be interrupted within 10 μsec. An additional requirement was that the total system have very low capacity such that the total energy stored would be less than 15 joules. This is a restriction imposed by the source designer to prevent destroying the source in case of an arc within the source.

28205 (LA-UR—80-1511) **Development of high-reliability, multi-kilohertz repetition-rate, fast-discharge components.** McDuff, G.; Rust, K.; Sarjeant, W.J.; Mace, P.N. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 4p. (CONF-800640—7). NTIS, PC A02/MF A01.

From 14. pulse power modulator symposium; Orlando, FL, USA (3 Jun 1980).

The two basic components in pulsed-power technology are capacitors and switches. In order to develop these high-voltage components, a unique laboratory has been constructed using state-of-the-art diagnostic and shielding techniques. The laboratory is comprised of three basic systems: charging systems, (2) diagnostic systems, and (3) grounding and shielding systems.

HEATING AND FUELING SYSTEMS

REFER ALSO TO CITATION(S) 28012

28206 (ANL/FPP/TM—132) **Evaluation of DD and DT fusion fuel cycles for different fusion-fission energy systems.** Gohar, Y. (Argonne National Lab., IL (USA)). Jan 1980. Contract W-31-109-ENG-38. 30p. NTIS, PC A03/MF A01.

A study has been carried out in order to investigate the characteristics of an energy system to produce a new source of fissile fuel for existing fission reactors. The denatured fuel cycles were used because it gives additional proliferation resistance compared to other fuel cycles. DT and DD fusion drivers were examined in this study with a thorium or uranium blanket for each fusion driver. Various fuel cycles were studied for light-water and heavy-water reactors. The cost of electricity for each energy system was calculated.

28207 (CONF-800455—11) **Studies of mechanisms of hydrogen recycle using a plasma-wall interaction experiment.** Clausing, R.E.; Emerson, L.C.; Heatherly, L. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 16p. NTIS, PC A02/MF A01.

From 4. international conference on plasma surface interactions in controlled fusion devices; Garmisch, F.R. Germany (21 Apr 1980).

It is shown that for type 304L stainless steel at room temperature and ion energies of 100 eV a large part of the recycling occurs with hydrogen residence times in the wall of about 100 ms. The use of wall temperatures from 80 to 500 K permits differentiation between thermally activated processes and ion bombardment-induced phenomena. For low energy ions (100 eV) onto 300 K stainless steel walls recycling increases to more than 90% in a few tenths of a second at 3×10^{16} ions $cm^{-2}s^{-1}$. For ions up to 300 eV at this flux there is little energy dependence. Both thermally and ion induced processes can be important at room temperature, but under the conditions of this study thermal processes greatly enhance the recycle rates at 300 and 500 K. Preliminary results indicate that recombination of atomic hydrogen to molecular hydrogen can be rate controlling in some practical regimes.

28208 (LBL—11011) **Commercialization of a high energy neutral beam ion source. Final report.** (McDonnell Douglas Astronautics Co., St. Louis, MO (USA)). 21 Dec 1979. Contract W-7405-ENG-48. 97p. NTIS, PC A05/MF A01.

This final report summarizes the effort and presents the results of a Phase II fabrication effort to build an industrial prototype of the LBL developed high energy neutral beam source. The effort was primarily concentrated on incorporating hard vacuum dielectric seals and a ceramic high voltage accelerator insulator. Several other design changes were incorporated for cost, reliability or life improvements to include: (1) accelerator grid locating dowel pins to aid final alignment, (2) plasma source to accelerator captive fasteners to aid filament replacement during source maintenance, (3) molybdenum cooling tubes on all accelerator grids, (4) additional fasteners in the plasma generator to facilitate hard seals, (5) modified suppressor grid rails and holders to simplify final grid alignment, (6) adjusting screws on exit grid rail holders to simplify final grid alignment, (7) addition of adjusting screws to the grid end pieces to simplify alignment, and (8) addition of accelerator hat shims to allow two different grid positioning locations.

28209 (UCRL—84018(Rev.1)) **Tandem mirror fusion-fission hybrid studies.** Lee, J.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Apr 1980. Contract W-7405-ENG-48. 27p. (CONF-800446—2(Rev.1)). NTIS, PC A03/MF A01.

From 2. international conference on emerging nuclear energy systems; Lausanne, Switzerland (8 Apr 1980).

Initial tandem mirror hybrid studies predict the ability to produce large amounts of fissile fuel (2 to 7 tons U233 per year from a 4000 MW plant) at a cost that adds less than 25% to the cost of power from a LWR.

28210 **Low-density ignition scenarios in injection-heated tokamaks.** Holmes, J.A.; Rome, J.A.; Houlberg, W.A.; Peng, Y.K.M.; Lynch, S.J. (Oak Ridge National Lab., TN (USA)). *Nucl. Fusion;* **20**: No. 1, 59-67(Jan 1980).

Plasma heating and ignition by neutral injection have been studied using a Monte-Carlo neutral-injection computer code coupled to a single-fluid, one-dimensional (1-D) transport code and a two-dimensional (2-D) flux-conserving equilibrium code. It is shown that, by taking advantage of central α-heating, profile effects, and flux surface shifts in elongated plasmas, it is possible to ignite a modelled, prototypical reactor plasma using 45-30 MW of 100-150 keV (D^+) neutral beams. To do this, the plasma is started at full bore but with a density below that needed for ignition. The density is then increased by peripheral fuelling so that the central core begins to ignite at the time when the neutral beams no longer penetrate to this region. The fusion α-particles take over the heating requirements in the core region. Because of the decreasing beam line efficiency with increasing energy, it is found that a nearly constant extracted power of about 85-95 MW is needed for ignition in the range studied. There is thus little economic difference in this energy range. However, higher-energy beams around 150 keV imply fewer injectors and perhaps lower impurity production rates during heating to ignition.

TRITIUM PROCESSING, ENVIRONMENT AND SAFETY

28211 (CONF-800427—12) **Tritium conversion and its influence on personnel protection at a fusion reactor.** Easterly, C.E.; Phillips, J.E. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 6p. NTIS, PC A02/MF A01.

From Tritium technology in fission, fusion, and isotopic application; Dayton, OH, USA (29 Apr 1980).

Tritium gas is less hazardous than tritiated water. The difference appears to be on the order of 10^4 rather than the previously used figure of 10^2. With an additional factor of 10^2 for protective clothing, a potential difference of 10^6 in the relative HTO to HT hazard results. The mechanisms for conversion of HT to HTO are not fully known but models presented strongly link the presence of H and OH radicals with the ultimate formation of water. Therefore a hindrance of this conversion may be possible by using specific quencher materials. The maintenance of tritium in the gaseous form then allows for a wider variety of tritium management schemes.

28212 (LA-UR—80-175) **Development of tritium technology for the United States magnetic fusion energy program.** Anderson, J.L.; Wilkes, W.R.; Maroni, V.A. (Los Alamos Scientific Lab., NM (USA); Mound Facility, Miamisburg, OH (USA); Argonne National Lab., IL (USA)). 1980. Contract W-7405-ENG-36. 3p. (CONF-800707—7). NTIS, PC A02/MF A01.

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Tritium technology development for the DOE fusion program is taking place principally at three laboratories, Argonne National Laboratory, Los Alamos Scientific Laboratory, and Mound Facility. This paper will review the major aspects of each of the three programs and look at aspects of the tritium technology being developed at other Laboratories within the United States.

POWER CONVERSION SYSTEMS

REFER ALSO TO CITATION(S) 28198

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 27596, 27598, 27603

28213 (LA-UR—80-1492) **Progress in inertial fusion research at the Los Alamos Scientific Laboratory. Paper No. IAEA-CN-38/B-2.** Perkins, R.B. (Los Alamos Scientific Lab., NM (USA)). 1980. Con-

tract W-7405-ENG-36. 16p. (CONF-800707—9). NTIS, PC A02/MF A01.

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

The Los Alamos Scientific Laboratory Inertial Confinement Fusion Program is reviewed. Experiments using the Helios CO_2 laser system delivering up to 6 kJ on target are described. Because breakeven energy estimates for laser drivers of 1 μm and above have risen and there is a need for CO_2 experiments in the tens-of-kilojoule regime as soon as practical, a first phase of Antares construction is now directed toward completion of two of the six original modules in 1983. These modules are designed to deliver 40 kJ of CO_2 laser light on target.

28214 (SAND—80-1355C) **Progress toward fusion with light ions.** (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 28p. (CONF-800707—8). NTIS, PC A03/MF A01.

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

New results in target design, beam generation and transport, and pulse power technology have led to a program shift stressing light ion-driven inertial confinement fusion. According to present estimates, a gain ten fusion pellet will require at least one megajoule and ~ 100 TW power input. Progress in ion sources has resulted in beam power density of ~ 1 TW/cm², a factor of ten increase over the last year, and cylindrical implosion experiments have been performed. Other experiments have demonstrated the ability to transport ion and electron beams with high efficiency and have confirmed numerical predictions on the properties of beam transport channels converging at a target. These developments together with improvements in pulse power technology allow us to project that the 72 beam, 100 TW Particle Beam Fusion Accelerator, PBFA-II will attain target output energy equal to stored energy in the accelerator.

28215 (SLAC-PUB—2490) **Inertial confinement fusion systems using heavy ion accelerators as drivers.** Herrmannsfeldt, W.B.; Godlove, T.F.; Keefe, D. (Stanford Linear Accelerator Center, CA (USA); Department of Energy, Washington, DC (USA); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract AC03-76SF00515. 20p. (LBL—10870; CONF-800446—3). NTIS, PC A02/MF A01.

From 2. international conference on emerging nuclear energy systems; Lausanne, Switzerland (8 Apr 1980).

Heavy ion accelerators are the most recent entrants in the effort to identify a practical driver for inertial confinement fusion. They are of interest because of the expected efficient coupling of ion kinetic energy to the thermal energy needed to implode the pellet and because of the good electrical efficiency of high intensity particle accelerators. The beam intensities required, while formidable, lie within the range that can be studied by extensions of the theories and the technology of modern high energy accelerators.

28216 (SLAC-PUB—2524) **Heavy ion beams for inertial fusion.** Godlove, T.F.; Herrmannsfeldt, W.B. (Department of Energy, Washington, DC (USA); Stanford Linear Accelerator Center, CA (USA)). May 1980. Contract AC03-76SF00515. 11p. (CONF-800466—3). NTIS, PC A02/MF A01.

From International conference on low energy ion beams 2; Bath, UK (14 Apr 1980).

The United States' program in inertial confinement fusion (ICF) is described in this paper, with emphasis on the studies of the use of intense high energy beams of heavy ions to provide the power and energy needed to initiate thermonuclear burn. Preliminary calculations of the transport of intense ion beams in an electrostatic quadrupole focussing structure are discussed.

28217 (UCID—18701) **Stepping motor control processor reference manual. Volume I.** Holloway, F.W.; VanArsdall, P.J.; Suski, G.J.; Gant, R.G.; Rash, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Jun 1980. Contract W-7405-ENG-48. 129p. NTIS, PC A07/MF A01.

This manual is intended to serve several purposes. The first goal is to describe the capabilities and operation of the SMC processor package from an operator or user point of view. Secondly, the manual will describe in some detail the basic hardware elements and how they can be used effectively to implement a step motor control system. Practical information on the use, installation and checkout of the hardware set is presented in the following sections along with programming suggestions. Available related system software is described in this manual for reference and as an aid in understanding the system architecture. Section two presents an overview and operations manual of the SMC processor describing its composition and functional capabilities. Section three contains hardware descriptions in some detail for the LLL-designed hardware used in the SMC processor. Basic theory of operation and important features are explained.

28218 (UCRL—52000-80-6, pp 9-18) **Argon x-ray line imaging: a compression diagnostic for inertial confinement fusion targets.** Jun 1980.

In Energy and technology review.

Various techniques were used to measure the ion temperature and density of the deuterium-tritium (D-T) fuel in an inertial confinement fusion (ICF) target in order to determine progress toward the goals of significant thermonuclear burn and net energy gain. The ion temperature of the fuel can be inferred from the measured yield of the fusion-reaction (14-MeV) neutrons; measuring the final fuel density is more difficult. New techniques - including argon x-ray line imaging and neutron activation - let us infer the compression obtained with our intermediate-density targets. Argon x-ray line imaging measures the compressed fuel volume directly by forming one-dimensional images of x rays from argon gas seeded into the D-T fuel; the photon energies of the x rays are recorded on the film of a diffraction-crystal spectrograph. Neutron activation, which detects activated nuclei produced by the interaction of 14-MeV neutrons with selected materials of the target, allows us (with the help of a hydrodynamics simulation code and knowledge of the total number of activated nuclei and neutron yield) to calculate the final compressed fuel density. Argon x-ray line imaging appears to be a valid fuel-compression diagnostic for final fuel densities in the range of 10 to 50 times liquid D-T density (2 to 10 g/cm³).

28219 (UCRL—83582(Rev.1)) **Optical coatings for laser fusion applications.** Lowdermilk, W.H.; Milam, D.; Rainer, F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Apr 1980. Contract W-7405-ENG-48. 28p. (CONF-800439—7(Rev.1)). NTIS, PC A03/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (21 Apr 1980).

Lasers for fusion experiments use thin-film dielectric coatings for reflecting, antireflecting and polarizing surface elements. Coatings are most important to the Nd:glass laser application. The most important requirements of these coatings are accuracy of the average value of reflectance and transmission, uniformity of amplitude and phase front of the reflected or transmitted light, and laser damage threshold. Damage resistance strongly affects the laser's design and performance. The success of advanced lasers for future experiments and for reactor applications requires significant developments in damage resistant coatings for ultraviolet laser radiation.

28220 **Automated alignment of a 10-kJ laser.** Partridge, R.E. pp 66-69 of Laser Focus Magazine. Newton, MA; Advanced Technology Publications (1979).

The complex task of aligning helios, the 10-kilojoule carbon-dioxide laser, built for fusion research at the Los Alamos Scientific Laboratory, requires computer control of steering mirrors and error sensors. The control system is a three-level minicomputer and microprocessor hierarchy which automatically aligns each of the 40 beamline sections.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

REFER ALSO TO CITATION(S) 27035

28221 (ANL/FPP/TM—133) **Self-consistent calculations of edge temperature and self-sputtering of the limiter surface for tokamak fusion reactors.** Brooks, J.N. (Argonne National Lab., IL (USA)). May 1980. Contract W-31-109-ENG-38. 20p. NTIS, PC A02/MF A01.

Self-sputtering and edge temperature estimates have been made for a tokamak fusion reactor with a normal incidence boundary using models for the power balance, plasma sheath, charge state, and sputtering coefficients. Both structural materials and low-Z coatings have been examined. From the self-sputtering standpoint, some materials will work only at very low edge temperatures; these will require a high recycling rate and a high radiation fraction.

28222 (BNL—27824) **Damage parameters for non-metals in a high energy neutron environment.** Dell, G.F.; Berry, H.C.; Lazareth, O.W.; Goland, A.N. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 28p. (CONF-800551—10). NTIS, PC A03/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

Simulation of radiation damage induced in monatomic and binary non-metals by FMIT and fusion neutrons is described. Damage produced by elastic scattering of recoil atoms and by ionization-assisted processes has been evaluated using the damage program DON. Displacement damage from gamma rays has been evaluated by using the technique of Oen and Holmes. A comparison of damage for an anticipated FMIT radiation environment generated by a coupled n-γ transport calculations and a fusion spectrum is made. Gamma-induced displacement damage is sufficiently small that it is dominated by neutron-induced recoil processes. Ionization-

assisted displacements may be important depending upon the ionization cross section of the particular non-metal under consideration.

28223 (CONF-800607—37) **One-dimensional gamma-ray shielding calculations for the EBT-P.** Lillie, R.A.; Gabriel, T.A.; Bishop, B.L.; Baker, V.C. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 11p. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

Due to the expected large loss of electrons on the magnetic coil assemblies and other components of the proposed EBT-P plasma device, the induced gamma-ray field from bremsstrahlung will be very intense. These gamma rays will yield increased heating loads on the superconducting cryogenic coils as well as produce a significant biological hazard. In this summary, the results from a series of one-dimensional calculations in which the gamma-ray heating loads were determined are presented for several coil shield configurations. Also, one-dimensional results which indicate the level of biological dose for varying thicknesses of either lead or concrete that have been proposed for the primary shielding are given.

28224 (CONF-800607—43) **Fatigue behavior of Type 316 stainless steel following neutron irradiation inducing helium.** Grossbeck, M.L.; Liu, K.C. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 5p. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

Since a tokamak reactor operates in a cyclic mode, thermal stresses will result in fatigue in structural components, especially in the first wall and blanket. There has been limited work on fatigue in irradiated alloys but none on irradiated materials containing significant amounts of irradiation-induced helium. To provide scoping data and to study the effects of irradiation on fatigue behavior, 20%-cold-worked type 316 stainless steel from the MFE reference heat was studied.

28225 (PNL—3335) **Preliminary evaluation of graphite in the FMIT test cell.** Morgan, W.C. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1980. Contract AC06-76RL01830. 38p. NTIS, PC A03/MF A01.

A design for the Test Cell of the Fusion Materials Irradiation Test facility includes composite steel-graphite cooling/shielding panels. A graphite damage fluence of about $3.2 \times 10^{20}/cm^2$ at about 80°C can be expected over 20 years of operation. This review defines the potential problem areas (stored energy and dimensional changes) and recommends approaches to avoid or alleviate those problems. It is concluded that the design is viable and that no insurmountable problems are likely to be encountered.

28226 (PPPL—1671) **Mechanisms responsible for topographical changes in PLT stainless steel and graphite limiters.** Cohen, S.A.; Budny, R.; McCracken, G.M.; Ulrickson, M. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jun 1980. Contract W-7405-ENG-36. 70p. NTIS, PC A04/MF A01.

Damage to PLT limiters used during ohmic and neutral beam heated discharges is described. The damage can be explained by the power and momentum fluxes of bulk plasma and beam ions and by disruptions. The plasma scrap-off distance inferred from the extent of the damage ranges from 5 to 30 mm and is consistent with a radially outward drift velocity of 2×10^4 mm/sec. A new model of the plasma scrape-off is presented which explains the pattern and extent of the damage.

28227 (UCRL—83405(Rev.1)) **Tritium experience at RTNS-II.** Logan, C.M.; Davis, J.C.; Gibson, T.A.; Heikkinen, D.W.; Schumacher, B.J.; Singh, M.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Apr 1980. Contract W-7405-ENG-48. 7p. (CONF-800427—16(Rev.1)). NTIS, PC A02/MF A01.

From Tritium technology in fission, fusion, and isotopic application; Dayton, OH, USA (29 Apr 1980).

Neutrons are produced at the Rotating Target Neutron Source-II (RTNS-II) by deuteron bombardment of a rotating tritium target. Tritium is released from these targets into the accelerator vacuum system. The vacuum system exhaust is first scrubbed and then vented via the facility stack. Tritium emission from the facility in normal operation with vacuum system exhaust flowing through the scrubber is extremely low, <1 mCi/day. Releases from bypassing the tritium scrubber during roughing of the vacuum system and from accelerator maintenance account for nearly all of the annual 10 Ci release from the facility. Routine target changes have been the cause of most tritium uptake by personnel. A target shipping system has been devised for transport of these targets.

28228 **Derivation of bending free toroidal shell shapes for tokamak fusion reactors.** Gray, W.H. (Oak Ridge National Lab., TN); Stoddart, W.C.T.; Akin, J.E. *J. Appl. Mech.;* **46**: No. 1, 120-124(Mar 1979).

This paper describes an extension of mathematical solutions to bending free shapes of toroidal pressure vessels. Previous work on this subject derived a pure tension shape of a toroidal membrane which was subjected to a uniform internal pressure. This research was directed toward the finding of a pure tension shape of a toroidal membrane which is subjected to a pressure inversely proportional to the square of the toroidal radius. Such a relationship is possible when electromechanical forces are considered. This family of shapes, which are nearly circular for aspect ratios greater than 2.5, is derived by solving the equilibrium, constitutive, and kinematic relationships for a uniform toroidal shell using the linear membrane theory. Serious consideration should be given to these toroidal shapes, as they provide alternative methods of design for tokamak fusion reactors.

GENERAL AND MISCELLANEOUS

28229 (LASL—78-12) **Laboratory activities.** (Los Alamos Scientific Lab., NM (USA)). Apr 1978. Contract W-7405-ENG-36. 127p. NTIS, PC A07/MF A01.

A brief explanation of the work done by the divisions, departments, and groups at LASL is given. (GHT)

MANAGEMENT

28230 (CONF-800509—3) **Managing people problems in changing to computerized text processing.** Walker, T.R. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 2p. NTIS, PC A02/MF A01.

From 27. international technical communication conference; Bloomington, MN, USA (14 May 1980).

Change is always both a promise and a threat. Changing to a computerized text processing system is, from a management viewpoint, mostly a promise; but from an employee viewpoint, mostly a threat. A variety of people problems arise from such a changeover because of the perceived threats involved. Most of these problems can be expected, so that, by proper management, their effects can be reduced or eliminated.

28231 (DOE/CS—0167) **State energy officials directory.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Conservation and Solar Energy). May 1980. 69p. NTIS, PC A04/MF A01.

A tabulation of state (and territory) energy officials is provided, along with lists of DOE officials and energy associations. (RWR)

28232 (UCRL—52000-80-6) **Energy and technology review.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1980. Contract W-7405-ENG-48. 19p. NTIS, PC A02/MF A01.

Three topics are covered: detecting genetic damage in humans, argon x-ray line imaging, and complete cutoff of Middle Eastern oil. Separate abstracts were prepared for each.

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 26834, 28051, 28130

28233 (ANL/ES—95) **Random numbers spring from alpha decay.** Frigerio, N.A.; Sanathanan, L.P.; Morley, M.; Clark, N.A.; Tyler, S.A. (Argonne National Lab., IL (USA)). May 1980. Contract W-31-109-ENG-38. 66p. NTIS, PC A04/MF A01.

Congruential random number generators, which are widely used in Monte Carlo simulations, are deficient in that the number they generate are concentrated in a relatively small number of hyperplanes. While this deficiency may not be a limitation in small Monte Carlo studies involving a few variables, it introduces a significant bias in large simulations requiring high resolution. This bias was recognized and assessed during preparations for an accident analysis study of nuclear power plants. This report describes a random number device based on the radioactive decay of alpha particles from a ^{235}U source in a high-resolution gas proportional counter. The signals were fed to a 4096-channel analyzer and for each channel the frequency of signals registered in a 20,000-microsecond interval was recorded. The parity bits of these frequency counts (0 for an even count and 1 for an odd count) were then assembled in sequence to form 31-bit binary random numbers and transcribed to a magnetic tape. This cycle was repeated as many times as were necessary to create 3 million random numbers. The frequency distribution of counts from the present device conforms to the Brockwell-Moyal distribution, which takes into account the dead time of the counter (both the dead time and decay constant of the underlying Poisson process were estimated). Analysis of the count data and tests of randomness on a sample set of the 31-bit binary

numbers indicate that this random number device is a highly reliable source of truly random numbers. Its use is, therefore, recommended in Monte Carlo simulations for which the congruential pseudorandom number generators are found to be inadequate. 6 figures, 5 tables.

28234 (BNL—27878) **More on approximations of Poisson probabilities.** Kao, C. (Brookhaven National Lab., Upton, NY (USA)). May 1980. Contract AC02-76CH00016. 16p. (CONF-800820—3). NTIS, PC A02/MF A01.

From American Statistical Society meeting; Houston, TX, USA (11 Aug 1980).

Calculation of Poisson probabilities frequently involves calculating high factorials, which becomes tedious and time-consuming with regular calculators. The usual way to overcome this difficulty has been to find approximations by making use of the table of the standard normal distribution. A new transformation proposed by Kao in 1978 appears to perform better for this purpose than traditional transformations. In the present paper several approximation methods are stated and compared numerically, including an approximation method that utilizes a modified version of Kao's transformation. An approximation based on a power transformation was found to outperform those based on the square-root type transformations as proposed in literature. The traditional Wilson-Hilferty approximation and Makabe-Morimura approximation are extremely poor compared with this approximation. 4 tables. (RWR)

28235 (COO—2382-0065) **Virtual address kernel modification for UNIX.** Whaley, A.D. (Illinois Univ., Urbana (USA)). Feb 1980. Contract AS02-76ER02383. 16p. (UILU-ENG—80-1707; UIUCDCS-R—80-1005). NTIS, PC A02/MF A01.

UNIX is a modern, popular, high-level language operating system running principally (but not exclusively) on PDP11 computers. One of the big problems with this system is a tight restriction on kernel memory due to the 32k word virtual address space of the PDP11. The work described here divides the kernel into modules that run in independent address spaces to overcome this problem. The main software effort was to develop software tools to make it easy to work with the seperate modules, and, where possible, to make the conversion without modifying the kernel source code. 1 figure.

28236 (COO—2383-0062) **Automatic multirate methods for ordinary differential equations.** Gear, C.W. (Illinois Univ., Urbana (USA)). Jan 1980. Contract AS02-76ER02383. 16p. (UIUCDCS-R—80-1000; UILU-ENG—80-1701). NTIS, PC A02/MF A01.

A study is made of the application of integration methods in which different step sizes are used for different members of a system of equations. Such methods can result in savings if the cost of derivative evaluation is high or if a system is sparse; however, the estimation and control of errors is very difficult and can lead to high overheads. Three approaches are discussed, and it is shown that the least intuitive is the most promising. 2 figures.

28237 (COO—2383-0063) **Compiling fast partial derivatives of functions given by algorithms.** Speelpenning, B. (Illinois Univ., Urbana (USA). Dept. of Computer Science). Jan 1980. Contract AS02-76ER02383. 87p. (UILU-ENG—80-1702; UIUCDCS-R—80-1002). NTIS, PC A05/MF A01.

If the gradient of the function y = f(x_1,..., x/sub n/) is desired, where f is given by an algoritym Af(x, n, y), most numerical analysts will use numerical differencing. This is a sampling scheme that approximates derivatives by the slope of secants in closely spaced points. Symbolic methods that make full use of the program text of Af should be able to come up with a better way to evaluate the gradient of F. The system Jake described produces gradients significantly faster than numerical differencing. Jake can handle algorithms Af with arbitrary flow of control. Measurements performed on one particular machine suggest that Jake is faster than numerical differencing for $n > 8$. Somewhat weaker results were obtained for the problem of computing Jacobians of arbitrary shape.

28238 (LA—8317-M) **LSI-11 primer.** Williams, J.M.; Goldwire, H.C.; Hamlin, G.A.; Hensley, W.K. (Los Alamos Scientific Lab., NM (USA)). Apr 1980. Contract W-7405-ENG-36. 55p. NTIS, PC A04/MF A01.

This primer was prepared to help beginning users of an LSI-11 minicomputer system get under way. It describes what to get, how to assemble it, and how to use it. The wording is simple and designed to communicate with the layman. 5 figures.

28239 (ORNL/CSD/TM—95) **Methods to ensure the standardization of FORTRAN software.** Gaffney, P.W.; Wooten, J.W. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 49p. NTIS, PC A03/MF A01.

Four software tools PFORT, DAVE, POLISH, and BRNANL, which may be used to ensure the standardization of FORTRAN software are introduced. First, FORTRAN computer programs are loosely classified into three groups. Then reasons are given why the program in two of these groups should adhere to a portable subset of the American National Standard (ANS) First FORTRAN 1966. Next, the software tools PFORT, DAVE, POLISH, and BRNANL, are briefly described, and an example of the output from PFORT, DAVE, and POLISH are given. Finally, the dissemination of information pertaining to the tools together with their availability is outlined. 11 figures.

28240 (ORNL/CSD/TM—99) **POLISH user's manual.** McCollough, D.H. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 34p. NTIS, PC A03/MF A01.

POLISH is a computer program used to provide a user with an easy-to-read source listing of his FORTRAN program. Written at the University of Colorado, POLISH has been installed on the Fusion Energy Division and the Computer Science Division DEC PDP-10 systems as well as the IBM systems at Oak Ridge. Portions of the original POLISH documentation written at the University of Colorado have been rewritten to provide Oak Ridge users with a basic guide for the use of this program.

28241 (ORNL/CSD/TM—107) **FTPCOP: A SAS procedure to access information in SAS data sets by generalized Fortran programs.** Gudmundson, C.W. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 23p. NTIS, PC A02/MF A01.

FTPCOP is a PL/I program executed as a Statistical Analysis System (SAS) procedure that will produce a sequential file of FORTRAN-readable records developed from any existing SAS data set. This procedure allows the FORTRAN programer the capability of coding generalized FORTRAN programs that will read the FTPCOP-produced output file, independent of the number or type of variables and observations selected from a SAS data set. One can, therefore, eliminate the need to restructure FORTRAN format statements, variable descriptions, etc., each time a different set of variables is selected from a SAS data set or a different SAS data set is procured. 4 figures.

28242 (ORNL/CSD/TM—108) **Conversion and improvement of the Rutherford Laboratory's magnetostatic computer code GFUN3D to the NMFECC CDC 7600.** Tucker, T.C. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 37p. NTIS, PC $6.50/MF $3.50.

The implementation of a version of the Rutherford Laboratory's magnetostatic computer code GFUN3D on the CDC 7600 at the National Magnetic Fusion Energy Computer Center is reported. A new iteration technique that greatly increases the probability of convergence and reduces computation time by about 30% for calculations with nonlinear, ferromagnetic materials is included. The use of GFUN3D on the NMFE network is discussed, and suggestions for future work are presented. Appendix A consists of revisions to the GFUN3D User Guide (published by Rutherford Laboratory(that are necessary to use this version. Appendix B contains input and output for some sample calculations. Appendix C is a detailed discussion of the old and new iteration techniques.

28243 (ORNL/CSD/TM—112) **PFORT user's manual.** Gaffney, P.W.; McCollough, D.H. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 17p. NTIS, PC A02/MF A01.

This user's manual for the software tool PFORT describes how to invoke PFORT on the computers at Oak Ridge and how to interpret the output from PFORT. 4 figures, 2 tables.

28244 (ORNL/CSD/TM—113) **DAVE user's manual.** McGaffey, R.W. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 87p. NTIS, PC A05/MF A01.

DAVE is a system for analyzing FORTRAN programs. It is designed to report the presence, or possible presence, of a wide variety of programing errors. In addition, it provides information on the usage of all local and global variables, and on the logical flow through a program. DAVE is written in FORTRAN and is designed for ease of protability.

28245 (ORNL/CSD/TM—114) **BRNANL user's manual.** McGaffey, R.W. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 37p. NTIS, PC A03/MF A01.

BRNANL is a FORTRAN program for identifying basic blocks in a FORTRAN program. Specifically, BRNANL will read an ANS FORTRAN 1966 program and generate a copy of the program that contains a subroutine call at the head of every basic block. The name and purpose of this subroutine are at the control of the user; therefore, BRNANL may be used to gather statistics about the performance of a program. For exaple, the sections of code that are executed in a program may be recorded, the sequence in which statements are executed may be recorded, etc. 4 figures.

28246 (ORNL/TM—7325) **LASL-ORNL fast digital data acquisition system.** Hendricks, R.W.; Seeger, P.A.; Scheer, J.W.; Suehiro, S. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 43p. NTIS, PC A03/MF A01.

A data acquisition system for recording multi-parameter digital data into a large memory array at 1 MHz is described. The system consists of a MOSTEK MK8600 2048K x 24-bit memory system, I/0 ports to various external devices including the CAMAC dataway, a memory incrementer and a daisy-chain of experiment-specific modules which calculate the memory address which is to be incremented. The design of the daisy-chain permits multiple modules and provides for easy modification as experimental needs change. Several specific examples are described.

28247 (SAND—80-0496) **LSQFT: a nonlinear least squares data fitting subroutine suitable for minicomputers.** Drotning, W.D. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 36p. NTIS, PC A03/MF A01.

The FORTRAN subroutine LSQFT is described which uses the Gauss method to fit nonlinear functions to data. This particular program is suitable for use on a minicomputer that is utilized for real-time data acquisition and analysis. A sample problem is described that requires a nine-parameter nonlinear fit to 200 data points. This problem serves both to illustrate the use of LSQFT and to compare its results with TJMAR1, a nonlinear parameter estimation program available in the Sandia MATHLIB, for the CDC 6600/7600 computers. The results of this comparison fit are identical to the significance of the input convergence criteria. The output of LSQFT includes the standard deviation of each fit parameter, which is useful for analysis of the significance of the parameters based on the input data or for evaluation of functional models used to fit to the data. Examples are given of the types of graphical output that can be generated from the results of LSQFT. The program is documented and listed in its entirety, and a user's guide is provided. 10 figures.

28248 (SAND—80-0538/1) **Remote hard copy. Volume 1. Programming manual.** Simons, R.W. (Sandia Labs., Albuquerque, NM (USA)). Mar 1980. Contract AC04-76DP00789. 13p. NTIS, PC A02/MF A01.

The application of various graphics languages and special control cards to create and route graphics files to the remote hard copy plotters is presented. Discussion and examples are given for using GCS, DISSPLA, and VTSCORS on the SCOPE 3.3, SCOPE 2, and NOS operating systems.

28249 (SAND—80-0538/2) **Remote hard copy. Volume 2. Operating manual.** Simons, R.W. (Sandia Labs., Albuquerque, NM (USA)). Mar 1980. Contract AC04-76DP00789. 22p. NTIS, PC A02/MF A01.

Procedures for operating the remote hard copy plotters are presented. Initializing the system, caring for the plotter, and interacting with the system are all covered. Descriptions of error conditions and how to operate diagnostics are presented.

28250 (SAND—80-1059) **Interactive data manipulation program. FAWTEK user guide.** Boyer, W.B.; Sauer, S. (Sandia National Labs., Albuquerque, NM (USA); Ktech Corp., Albuquerque, NM (USA)). Feb 1980. Contract AC04-76DP00789. 47p. NTIS, PC A03/MF A01.

This report describes the interactive data acquisition and manipulation program FAWTEK. The program allows users of the electron beam data acquisition facility to control the R7912 digitizers and to perform a variety of mathematical operations on data arrays. Commands are entered in a high level language via a Tektronix 4010 terminal console. Each command directive and associated parameters is described in detail.

28251 (SAND—80-1328C) **Horizontal actuator data acquisition system.** Smith, E.L. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 12p. (CONF-800574—2). NTIS, PC A02/MF A01.

From IMOG meeting held on subgroup environmental testing; Albuquerque, NM, USA (20 May 1980).

A stand-alone digital acquisition and reduction system for the Actuator Test Facility is in the late stage of development. When finished, this system will alleviate current test control, test analysis, and data presentation problems. In its initial configuration it will digitize test results recorded on FM tape and present the data graphically for reports. The ultimate goal of this minicomputer-based system is to upgrade the test quality, safety, and turnaround time, with an improvement in data quality, analysis, and presentation.

28252 (UCID—17526(Rev.2)) **MST-80B microcomputer trainer.** Jones, G.D.; Fisher, E.R.; Spann, J.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Apr 1980. Contract W-7405-ENG-48. 37p. NTIS, PC A03/MF A01.

The microcomputer revolution in electronics is spreading so rapidly that it is difficult to educate enough people quickly and thoroughly in the new technology. Lawrence Livermore Laboratory's MST-80B was developed as a way to speed learning in in-house training courses, and it is now being widely used outside LLL. The MST-80B trainer is a complete, self-contained, microcomputer system housed in a briefcase. The trainer uses the Intel 8080A 8-Bit Microprocessor (CPU), and it has its own solid-state memory, a built-in keyboard, input and output ports, and a display for visual output. The trainer is furnished with a permanent Monitor Program (in Read-Only Memory) that allows users to enter, debug, modify, and run programs of their own easily. 8 figures, 3 tables.

28253 (UCID—30178) **QUAD: line-printer graphics that are DD80- and TV80-compatible.** Cox, L.A. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Oct 1979. Contract W-7405-ENG-48. 24p. NTIS, PC A02/MF A01.

The QUAD graphics library is a collection of FORTRAN subroutines that produce graphical output on conventional line printers. These routines have been written to aid in the conversion of LTSS codes that use DD80 or TV80 graphics routines to more standard FORTRAN systems, especially the Digital Equipment Corporation RT-11 and RSK-11 FORTRAN systems. Since DEC FORTRAN closely resembles ANSII Standard FORTRAN, and since the LLL DD80 graphics routines were largely derived from CALCOMP plotting software, the QUAD graphics routines were largely derived from CALCOMP plotting software, the QUAD graphics routines may be useful in a wide range of situations where software compatibility is important. 2 figures.

28254 (UCRL—82247) **Dissimulation.** George, L.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Mar 1980. Contract W-7405-ENG-48. 4p. (CONF-800819—1). NTIS, PC A02/MF A01.

From Summer computer simulation conference; Seattle, WA, USA (25 Aug 1980).

Simulation inputs are the distribution functions of random variables. Simulation transofrms inputs into outputs. Accuracy of outputs depends on uncertainty about input distribution functions. Randomizing parameters of the distribution functions as well as random variables is one way to represent this uncertainty. Randomizing the parameters alone results in dissimulation. Dissimulation generates the wrong output. Insidious dissimulation can occur when both parameters and random variables are randomized. Outputs obtained from simulation with randomly generated parameters and random variables have unnecesary sampling error. The outputs have larger variance than they should have. Simulation with expected distribution functions eliminates this error. 5 figures.

28255 (UCRL—83977) **Design of figuring pads for axisymmetric aspherizing.** Brown, N.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 30p. (CONF-800569—1). NTIS, PC A02/MF A01.

From Spring conference on applied optics; Oakland, CA, USA (31 May 1980).

This report presents small calculator and computer routines to predict axisymmetric lens figuring.

28256 (UCRL—50400(Vol.17)(Pt.B)(Rev.2)) **Program SIGMA1 (version 79-1): Doppler broaden evaluated cross sections in the evaluated nuclear data file/version B (ENDF/B) format.** Cullen, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Oct 1979. Contract W-7405-ENG-48. 37p. NTIS, PC A03/MF A01.

Program SIGMA1 Doppler-broadens evaluated cross sections in the ENDF/B format. The program requires that input cross sections be tabulated as linearly interpolable functions of energy in ENDF/B File 3; broadened cross sections, in this same form, replace the original values in the output tape. This report describes the methods used in the code and serves as a user's guide. A listing of the source deck is available on request.

28257 (UCRL—500400(Vol.17)(Pt.A)(Rev.2)) **Program LINEAR (version 79-1): linearize data in the evaluated nuclear data file/version B (ENDF/B) format.** Cullen, D.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Oct 1979. Contract W-7405-ENG-48. 24p. NTIS, PC A02/MF A01.

Program LINEAR converts evaluated cross sections in the ENDF/B format into a tabular form that is subject to linear-linear interpolation in energy and cross section. The code also thins tables of cross sections already in that form (i.e., removes points not needed for linear interpolability). The main advantage of the code is that it allows subsequent codes to consider only linear-linear data. A listing of the source deck is available on request.

28258 **Minimally 2-edge-connected graphs.** Maurer, S.B. (Princeton Univ., NJ); Slater, P.J. *Ann. N.Y. Acad. Sci.;* **319**: 377-382(14 May 1979).

Minimally 2-edge-connected graphs are characterized. These are graphs that are 2-edge-connected such that, when any edge is removed, the remaining graph is only 1-edge connected. The graphs are finite with multiple edges allowed. Loops are not allowed, since any minimally 2-edge-connected graph could not have them anyway. Since 2-edge-connected graphs are the edge analogs of

blocks, they have a theory like blocks, only simpler. 3 figures. (RWR)

28259 Data acquisition system at Los Alamos P-9 accelerator facility. Poore, R.V.; McMillan, D.E.; Nelson, R.O.; Sunier, J.W. (Los Alamos Scientific Lab., NM). *IEEE Trans. Nucl. Sci.;* **NS-26**: No. 1, 708-709(Feb 1979).

The computer facility consists of 3 MODCOMP IV/25 machines coupled together via shared memory with each computer interfaced to a CAMAC system. A program named Z has been written to allow user interaction with the CAMAC data acquisition system. Central to the structure of this program are creation of new operator commands with ease, macro or multiple command capability and a flexible, general, multiparameter data acquisition algorithm. A CAMAC branch driver has been built to allow high speed communication with the data acquisition modules.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 27870, 27872

28260 (CONF-800509—4) **Implementing a computerized text-management system: an editor's view.** Mason, J.D. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 5p. NTIS, PC A02/MF A01.

From 27. international technical communication conference; Bloomington, MN, USA (14 May 1980).

The advent of sophisticated function-key-driven programs for handling text on a video-display terminal enables the editorial staff of a publications department to take an active role on a computerized text-management team, along with compositors and other keyboard operators. Although there are still many things that editors cannot do on a computer terminal, the bulk of manipulating straight text can be speeded, and the problems of rekeyboarding and interpretation of editorial markings can be largely bypassed. The computer also gives editors new tools that open the way for greater control over both the editorial process and the quality of technical publishing. 5 figures.

28261 (CONF-800509—5) **Planning a text-management system for technical publications at Oak Ridge National Laboratory.** Williams, E.N.; McCulloch, R.D. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 13p. NTIS, PC A02/MF A01.

From 27. international technical communication conference; Bloomington, MN, USA (14 May 1980).

The planning and evolution of the centralized text-management system (CTMS) being implemented by the Technical Publications Department of the Oak Ridge National Laboratory's Information Division is described. The CTMS is a shared-logic system that provides for easy composition of technical documentation, including multilevel mathematics and complex tables. 3 figures.

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In the Corporate Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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AC03-78ET20419	Barber-Nichols Engineering Co., Arvada, CO (USA)	
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AC03-78ET21074	RCA Labs., Princeton, NJ (USA)	
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AC03-79ET15397	Science Applications, Inc., La Jolla, CA (USA)	
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AC03-79ET23044	State Univ. of New York, Buffalo (USA). Dept. of Electrical Engineering	
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AC03-79ET27232	WESTEC Services, Inc., San Diego, CA (USA)	
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AC04-76-DP00487	Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)	
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AC04-76-DP00789	Texas A and M Univ., College Station (USA). Dept. of Mechanical Engineering	
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AC04-76CS53682	Michigan Univ., Ann Arbor (USA). Dept. of Mechanical Engineering	
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AC04-76DP00053	Mound Facility, Miamisburg, OH (USA)	
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AI01-77ET10350	National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center	
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AI03-79ET37116	Jet Propulsion Lab., Pasadena, CA (USA)	
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AS02-76EV02386	New York Univ., NY (USA). Dept. of Physics	
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	5:27618	NTIS, PC A10/MF A01
	5:27619	NTIS, PC A10/MF A01
	5:27620	NTIS, PC A10/MF A01
	5:27621	NTIS, PC A10/MF A01
CONF-7906167-		(ASAE and CSAE Canadian Society of Agricultural Engineering summer meeting, Winnipeg, Canada, 24-27 Jun 1979)
	5:27135	7(1979)
	5:27136	11(1979)
	5:27150	17(1979)
	5:27151	26(1979)
	5:27154	10(1979)
	5:27155	25(1979)
	5:27156	18(1979)
	5:27157	19(1979)
	5:27167	17(1979)
	5:27357	27(1979)
CONF-790757-		(ARPA/AF review of progress in quantitative NDE, La Jolla, CA, USA, 8-13 Jul 1979)
4	5:28155	*See* UCRL-84116
CONF-7908102-		(International conference on two-photon interactions, Lake Tahoe, CA, USA, 30 Aug-1 Sep 1979)
3	5:28066	*See* SLAC-PUB-2464
CONF-791022-		(4. national passive solar energy conference, Kansas City, KS, USA, 3-5 Oct 1979)
14	5:27145	NTIS, PC A02/MF A01
CONF-791082-		(DOE automotive technology development contractors coordination meeting, Dearborn, MI, USA, 23-25 Oct 1979)
(Summ.)	5:27334	NTIS, PC A99/MF A01
(Summ.)	5:27335	NTIS, PC A99/MF A01
(Summ.)	5:27338	NTIS, PC A99/MF A01
(Summ.)	5:27375	NTIS, PC A99/MF A01
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(Summ.)	5:27379	NTIS, PC A99/MF A01
(Summ.)	5:27380	NTIS, PC A99/MF A01
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(Summ.)	5:27402	NTIS, PC A99/MF A01
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(Summ.)	5:27437	NTIS, PC A99/MF A01
(Summ.)	5:27438	NTIS, PC A99/MF A01
(Summ.)	5:27439	NTIS, PC A99/MF A01
(Summ.)	5:27440	NTIS, PC A99/MF A01
(Summ.)	5:27441	NTIS, PC A99/MF A01
(Summ.)	5:27442	NTIS, PC A99/MF A01
(Summ.)	5:27443	NTIS, PC A99/MF A01
(Summ.)	5:27444	NTIS, PC A99/MF A01
(Summ.)	5:27445	NTIS, PC A99/MF A01
(Summ.)	5:27446	NTIS, PC A99/MF A01
(Summ.)	5:27447	NTIS, PC A99/MF A01
CONF-791086-		(US/United Kingdom information exchange on dissolution of nuclear fuel, Windscale, UK, 16-18 Oct 1979)
4	5:26949	NTIS, PC A02/MF A01
CONF-7910103-		(Workshop on the production of new particles in super high energy collisions, Madison, WI, USA, 22-24 Oct 1979)
6	5:28072	*See* COO-881-117
7	5:28053	*See* COO-881-118
8	5:28056	*See* COO-881-120
CONF-7910166-		(2. symposium on the Cerro Prieto Geothermal Field, Baja California, Mexico, 17-19 Oct 1979)
3	5:27172	*See* LBL-9550
4	5:27171	*See* LBL-9549
CONF-791135-		(21. annual meeting of the American Physical Society, Boston, MA, USA, 12-16 Nov 1979)
13	5:27530	*See* UCRL-83089
CONF-791157-		(Conference on group theoretical methods in physics, Zvenigorod, USSR, 28-30 Nov 1979)
2	5:28064	*See* ORO-3992-385
CONF-791176-		(Japan-USA seminar on synchrotron radiation facilities, Honolulu, HI, USA, 5-9 Nov 1979)
4	5:27637	*See* BNL-27758
CONF-791216-		(Conference on long-term energy resources, Montreal, Canada, 3-4 Dec 1979)
3	5:27258	*See* BNL-27603
CONF-791231-		(17. General Assembly of the International Union of Geodesy and Geophysics, Canberra, Australia, Dec 1979)
2	5:27666	*See* COO-2195-35
CONF-791232-		(Thermal energy storage review meeting, Tysons Corner, VA, USA, 3 Dec 1979,-4 Dec 1979/REPLACES CONF-791242)
	5:27314	NTIS, PC A99/MF A01
CONF-791234-		(Environmental decontamination workshop, Oak Ridge, TN, USA, 4-5 Dec 1979)
3	5:27725	*See* RHO-SA-169
4	5:27578	*See* RHO-SA-168
5	5:27577	*See* RHO-SA-167
CONF-800116-		(Optical and infrared program conference, Tucson, AZ, USA, 7-12 Jan 1980)
2	5:27646	*See* LBL-10136
CONF-800126-		(Conference on atomic physics and spectroscopy for supernovae spectra, San Diego, CA, USA, 10-12 Jan 1980)
3	5:28005	*See* UCRL-84578

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CONF-800204-		(Energy-sources technology conference, New Orleans, LA, USA, 3-7 Feb 1980)
9	5:27042	*See* BNL-27457
CONF-800205-		(American Institute of Metallurgical Engineers meeting, Las Vegas, NV, USA, Feb 1980)
11	5:26909	NTIS, PC A02/MF A01
CONF-800237-		(International symposium on coastal upwelling, Los Angeles, CA, USA, 4-8 Feb 1980)
2	5:27726	*See* BNL-27757
CONF-800240-		(Deep underwater muon and neutrino detection signal processing workshop, Honolulu, HI, USA, 11-16 Feb 1980)
1	5:27634	*See* LBL-10548
CONF-800241-		(Workshop on contemporary Scandinavian-American issues, Minneapolis, MN, USA, 29 Feb-1 Mar 1980)
1	5:27304	*See* LBL-10501
CONF-800243-		(Wire chamber conference, Vienna, Austria, 27-29 Feb 1980)
1	5:27644	*See* BNL-27899
CONF-800313-		(Waste management conference, Tucson, AZ, USA, 10 Mar 1980)
8	5:26981	*See* RHO-SA-145
CONF-800320-		(3. topical conference on high temperature plasma diagnostics, Los Angeles, CA, USA, 17-19 Mar 1980)
5	5:27635	*See* UCRL-83808
CONF-800327-		(2. joint conference on applications of air pollution meteorology, New Orleans, LA, USA, 24-27 Mar 1980)
11	5:27204	*See* BNL-27505
CONF-800329-		(1. workshop on nuclear dynamics, Tahoe City, CA, USA, 17-21 Mar 1980)
3	5:28093	*See* LBL-10721
CONF-800334-		(2. DOE environmental control symposium, Reston, VA, USA, 17-19 Mar 1980)
13	5:26809	NTIS, PC A02/MF A01
CONF-800355-		(State energy audit impact '80 conference, St Louis, MO, USA, 31 Mar-2 Apr 1980)
	5:27306	Norcross, GA; American Inst. of Industrial Engineers (1980).
CONF-800359-		(NEA specialist meeting on decommissioning requirements in the design of nuclear facilities, Paris, France, 17-19 Mar 1980)
2	5:26959	*See* RHO-SA-149
CONF-800365-		(International conference on the ecological impact of acid precipitation, Sandefjord, Norway, 11-14 Mar 1980)
1	5:27923	*See* UCRL-83453
3	5:27710	*See* BNL-27851
4	5:27727	*See* BNL-27847
5	5:27920	*See* BNL-27848
6	5:27728	*See* BNL-27850
CONF-800374-		(15. Rencontre de Moriond, Les Arcs, France, 9-21 Mar 1980)
3	5:28075	*See* SLAC-PUB-2512
CONF-800376-		(Toxic substances in the environment, Battelle Columbus, OH, USA, Mar 1980)
1	5:27705	NTIS, PC A03/MF A01
CONF-800377-		(Meeting on radioactive waste storage in mined caverns, Stockhol, Sweden, 4-6 Mar 1980)
1	5:26995	*See* RHO-BWI-SA-51
CONF-800388-		(12. research conference on cerebral vascular disease, Williamsburg, VA, USA, 2-4 Mar 1980)
1	5:27818	*See* BNL-27845
CONF-800402-		(International symposium on the properties and applications of metal hydrides, Colorado Springs, CO, USA, 7-11 Apr 1980)
13	5:27049	NTIS, PC A03/MF A01
14	5:27503	*See* MLM-2733(OP)
CONF-800406-		(Wind energy conference, Boulder, CO, USA, 9-11 Apr 1980)
5	5:27192	*See* RFP-3085
6	5:27193	*See* RFP-3086
7	5:27188	*See* RFP-3087
CONF-800411-		(SPE/DOE symposium on enhanced oil recovery, Tulsa, OK, USA, 20-23 Apr 1980)
	5:26838	Dallas, TX; Society of Petroleum Engineers (1980).
CONF-800416-		(UCC-ND and GAT waste management seminar program, Portsmouth, OH, USA, 22-23 Apr 1980)
8	5:26945	*See* K/ET-5015
9	5:27737	NTIS, PC A02/MF A01
CONF-800421-		(IEEE international symposium on circuits and systems, Houston, TX, USA, 28-30 Apr 1980)
4	5:27207	NTIS, PC A04/MF A01
CONF-800427-		(Tritium technology in fission, fusion, and isotopic application, Dayton, OH, USA, 29 Apr-1 May 1980)
12	5:28211	NTIS, PC A02/MF A01
15	5:27559	NTIS, PC A02/MF A01
16(Rev.1)	5:28227	*See* UCRL-83405(Rev.1)
CONF-800428-		(6. international conference on fluidized bed combustion, Atlanta, GA, USA, 9-11 Apr 1980)
6	5:27617	NTIS, PC A02/MF A01
CONF-800429-		(Institute of Gas Technology conference on future alternatives in residential and commercial space conditioning, Chicago, IL, USA, 14-17 Apr 1980)
2	5:27311	*See* BNL-27519
CONF-800433-		(4. international conference on nuclear methods in environment and energy research, Columbia, MO, USA, 14-17 Apr 1980)
4	5:27744	NTIS, PC A02/MF A01
5	5:27970	*See* BNL-27859
6	5:27971	*See* BNL-27888
CONF-800439-		(International conference on metallurgical coatings, San Diego, CA, USA, 21-25 Apr 1980)
4	5:27508	*See* LBL-10607
7(Rev.1)	5:28219	*See* UCRL-83582(Rev.1)
8	5:27200	*See* DOE/NASA/2593-16
CONF-800445-		(6. international conference and exhibition on liquefied natural gas, Kyoto, Japan, 7-14 Apr 1980)
(Vol.1)	5:26896	$60.00 (Vols. 1 and 2)
(Vol.2)	5:26907	$60.00 (Vols. 1 and 2)
CONF-800446-		(2. international conference on emerging nuclear energy systems, Lausanne, Switzerland, 8-11 Apr 1980)
2(Rev.1)	5:28209	*See* UCRL-84018(Rev.1)
3	5:28215	*See* SLAC-PUB-2490
4	5:27037	*See* BNL-27784
CONF-800452-		(International conference on nuclear behavior at high angular momentum, Strassbourg, France, 22-24 Apr 1980)
2	5:27639	NTIS, PC A02/MF A01
CONF-800455-		(4. international conference on plasma surface interactions in controlled fusion devices, Garmisch, F.R. Germany, 21-25 Apr 1980)
11	5:28207	NTIS, PC A02/MF A01
13	5:28169	NTIS, PC A02/MF A01
14	5:28170	*See* SAND-80-1180C
15	5:28012	*See* UCRL-84262
CONF-800456-		(Sherwood theory meeting, Tucson, AZ, USA, 23-25 Apr 1980)
2	5:28186	NTIS, PC A02/MF A01
CONF-800466-		(International conference on low energy ion beams 2, Bath, UK, 14-17 Apr 1980)
3	5:28216	*See* SLAC-PUB-2524
CONF-800469-		(1. workshop on grand unification, Durham, NH, USA, 10-12 Apr 1980)
2	5:28006	*See* DOE/ER/03069-777
CONF-800471-		(Seminar on theory and applications of Monte Carlo methods, Oak Ridge, TN, USA, Apr 1980)
4	5:28121	NTIS, PC A02/MF A01
CONF-800473-		(19. JOWOG-12 meeting, Albuquerque, NM, USA, 29 Apr 1979,-2 May 1980)
1	5:27458	*See* UCRL-84368
CONF-800478-		(Workshop on the use of multivariate statistics in studies of wildlife habitat, Burlington, VT, USA, 23-25 Apr 1980)
1	5:27706	NTIS, PC A02/MF A01
CONF-800484-		(Reversed field pinch theory workshop, Los Alamos, NM, USA, 28 Apr-2 May 1980)
2	5:28168	*See* LA-UR-80-1875
CONF-800487-		(Workshop on laboratory EXAFS sources, Seattle, WA, USA, 28-30 Apr 1980)
1	5:27638	*See* BNL-27844
CONF-800488-		(International conference on nuclear behavior at high angular momentum, Strasbourg, France, Apr 1980)
1	5:28086	*See* BNL-27911

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CONF-800507-		(Rock mechanics symposium, Rolla, MO, USA, 27-30 May 1980)
6	5:28000	*See* UCRL-83653
7(Rev.)	5:26986	*See* LBL-10193(Rev.)
CONF-800509-		(27. international technical communication conference, Bloomington, MN, USA, 14-17 May 1980)
3	5:28230	NTIS, PC A02/MF A01
4	5:28260	NTIS, PC A02/MF A01
5	5:28261	NTIS, PC A02/MF A01
CONF-800523-		(3. international electric vehicle exposition and conference, St. Louis, MO, USA, May 1980)
3	5:27419	*See* DOE/NASA/1044-7
CONF-800525-		(SPE/DOE symposium on unconventional gas recovery, Pittsburgh, PA, USA, 18-21 May 1980)
4	5:27176	NTIS, PC A02/MF A01
CONF-800527-		(International BHP symposium, Columbus, OH, USA, 7-9 May 1980)
5	5:27003	*See* SAND-80-0358C
CONF-800529-		(American Society for Information Service mid-year meeting, Pittsburgh, PA, USA, 15 May 1980)
2	5:26834	*See* LBL-10270
CONF-800535-		(ASME Idaho section symposium, Idaho Falls, ID, USA, 29 May 1980)
2	5:26997	*See* RHO-SA-170
CONF-800541-		(Tar sands permeability enhancement workshop, Albuquerque, NM, USA, 8-9 May 1980)
2	5:26911	*See* SAND-80-1203C
CONF-800542-		(Concrete decontamination workshop, Seattle, WA, USA, 28-29 May 1980)
2	5:27574	NTIS, PC A03/MF A01
3	5:27575	*See* LA-UR-80-1460
CONF-800548-		(Eastern Economic Association annual meeting, Montreal, Quebec, Canada, 8-10 May 1980)
3	5:27325	NTIS, PC A02/MF A01
CONF-800549-		(11. annual modeling and simulation conference, Pittsburgh, PA, USA, 1 May 1980)
2	5:27302	*See* BNL-27802
3	5:27707	NTIS, PC A02/MF A01
CONF-800551-		(Symposium on neutron cross sections from 10 - 50 MeV, Upton, NY, USA, 12-14 May 1980)
2	5:28101	*See* UCRL-84344
3	5:28091	NTIS, PC A02/MF A01
4	5:28176	NTIS, PC A02/MF A01
5	5:28094	*See* UCRL-84341
6	5:28112	*See* UCRL-84342
7	5:28092	*See* LA-UR-80-1328
8	5:28096	*See* LA-UR-80-1327
10	5:28222	*See* BNL-27824
11	5:28116	*See* UCRL-84369
CONF-800554-		(American Society for Microbiology conference, Miami, FL, USA, 11-16 May 1980)
1	5:27731	*See* DP-MS-80-21
CONF-800556-		(Annual spring meeting of the American Geophysical Union, Toronto, Ontario, Canada, 22-24 May 1980)
2	5:27995	*See* RHO-SA-164
CONF-800559-		(International federation of automatic control symposium on water and related resources systems, Cleveland, OH, USA, 28-31 May 1980)
1	5:26810	NTIS, PC A02/MF A01
CONF-800561-		(International conference on ordering in two dimensions, Lake Geneva, WI, USA, 28-30 May 1980)
1	5:28011	*See* DOE/ER/10454-3
2	5:28131	NTIS, PC A02/MF A01
CONF-800565-		(TIMS/ORSA national meeting, Washington, DC, USA, 4-7 May 1980)
1	5:26996	*See* RHO-SA-142
2	5:27340	*See* BNL-27862
CONF-800569-		(Spring conference on applied optics, Oakland, CA, USA, 31 May-6 Jun 1980)
1	5:28255	*See* UCRL-83977
CONF-800571-		(Canadian Operations Research Society meeting, Quebec, Canada, 20-22 May 1980)
2	5:27282	*See* BNL-27816
CONF-800574-		(IMOG meeting held on subgroup environmental testing, Albuquerque, NM, USA, 20 May 1980)
1	5:27613	*See* SAND-80-1290C
2	5:28251	*See* SAND-80-1328C
CONF-800575-		(4. SESA international congress on experimental mechanics, Boston, MA, USA, 25-30 May 1980)
1	5:26921	NTIS, PC A02/MF A01
CONF-800577-		(6. Canadian symposium on remote sensing, Halifax, Canada, 21-23 May 1980)
1	5:26994	*See* RHO-BWI-SA-43
CONF-800581-		(Committee on materials (COMAT) meeting, Washington, DC, USA, 22 May 1980)
1	5:27449	NTIS, PC A02/MF A01
CONF-800602-		(Symposium on instrumentation and control for fossil energy processes, Virginia Beach, VA, USA, 9-11 Jun 1980)
1	5:26788	*See* SAND-80-1176C
2	5:26783	*See* MLM-2728(OP)
5	5:27972	NTIS, PC A02/MF A01
6	5:26805	*See* LA-UR-80-1625
CONF-800604-		(American section of the International Solar Energy Society conference, Phoenix, AZ, USA, 2-6 Jun 1980)
25	5:27062	*See* LBL-10802
26	5:27114	*See* SERI/TP-623-643
28	5:27161	*See* IS-M-278
29	5:27149	*See* IS-M-277
CONF-800605-		(International symposium on electrical insulation, Boston, MA, USA, 9-11 Jun 1980)
2	5:27216	*See* BNL-27331
CONF-800607-		(American Nuclear Society annual meeting, Las Vegas, NV, USA, 8-13 Jun 1980)
37	5:28223	NTIS, PC A02/MF A01
38	5:27883	NTIS, PC A02/MF A01
41	5:28129	NTIS, PC A02/MF A01
43	5:28224	NTIS, PC A02/MF A01
44	5:28113	NTIS, MF A01
60	5:27237	NTIS, PC A03/MF A01
CONF-800610-		(American Institute of Chemical Engineering conference, Philadelphia, PA, USA, 8-12 Jun 1980)
7	5:26798	NTIS, PC A02/MF A01
8	5:26795	*See* UCRL-84458
CONF-800611-		(International symposium on the management of alpha-contaminated wastes, Vienna, Austria, 2-6 Jun 1980)
7	5:26980	*See* RFP-3030
8	5:26974	*See* LA-UR-80-1428
CONF-800614-		(11. international quantum electronics conference, Boston, MA, USA, 23-26 Jun 1980)
2	5:27563	*See* SAND-80-1370C
CONF-800616-		(3. world hydrogen energy conference, Tokyo, Japan, 23-26 Jun 1980)
6(Rev.)	5:27044	*See* GA-A-15777(Rev.)
8	5:27051	NTIS, PC A02/MF A01
CONF-800617-		(7. international conference on MHD electrical power generation, Cambridge, MA, USA, 16-20 Jun 1980)
6	5:27290	NTIS, PC A02/MF A01
CONF-800628-		(JOWOG-28 conference, Kansas City, MO, USA, 16-18 Jun 1980)
2	5:27512	*See* UCRL-84303
3	5:27513	*See* UCRL-84304
CONF-800629-		(Symposium on commercial uses of geothermal energy, Boise, ID, USA, 16-18 Jun 1980)
2	5:27181	NTIS, PC A02/MF A01
CONF-800631-		(8. international cryogenic engineering conference, Genoa, Italy, 3-6 Jun 1980)
7	5:27589	*See* LA-UR-80-1566
CONF-800632-		(ASTM symposium on using fire tests for quantitative risk assessment, Hilton Head, SC, USA, 4 Jun 1980)
1	5:27987	*See* LBL-10827
CONF-800635-		(Conference of the American Society of Heating, Refrigeration and Air Conditioning Engineers, Denver, CO, USA, 22-26 Jun 1980)
3	5:27315	NTIS, PC A02/MF A01
CONF-800639-		(International symposium on solar thermal power, Marseilles, France, 15-20 Jun 1980)
1	5:27130	*See* COO-4878-14

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CONF-800640-	(14. pulse power modulator symposium, Orlando, FL, USA, 3-5 Jun 1980)	
3	5:28204	*See* GA-A-15903
7	5:28205	*See* LA-UR-80-1511
10	5:27633	*See* LA-UR-80-1510
11	5:27631	*See* SAND-80-0476C
13	5:27610	*See* SAND-80-0506C
CONF-800641-	(International conference on the metallurgical effects of high strain rate deformation and fabrication, Albuquerque, NM, USA, 22-26 Jun 1980)	
2	5:27606	*See* SAND-80-1301C
3	5:27475	*See* SAND-80-1325C
4	5:27472	*See* LA-UR-80-1659
5	5:27471	*See* LA-UR-80-1649
CONF-800642-	(International gas research conference, Chicago, IL, USA, 9-12 Jun 1980)	
3	5:27266	*See* LBL-10896
CONF-800645-	(Special session on nuclear waste disposal, Stockholm, Sweden, 23-27 Jun 1980)	
1	5:26989	*See* LBL-10849
2	5:26987	*See* LBL-10358
CONF-800646-	(International laser/electro-optics training conference, Wausau, WI, USA, Jun 1980)	
1	5:27597	*See* LA-UR-80-1480
CONF-800647-	(International conference on the physics of MOS insulators, Raleigh, NC, USA, 18-20 Jun 1980)	
1	5:28132	*See* SAND-80-0486C
2	5:27457	*See* SAND-80-0431C
CONF-800648-	(GCFRP program technical review meeting, San Diego, CA, USA, 4-6 Jun 1980)	
1	5:27222	NTIS, PC A03/MF A01
CONF-800650-	(Symposium on oil and gas supply modeling, Washington, DC, USA, 18-20 Jun 1980)	
1	5:26835	NTIS, PC A04/MF A01
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2	5:28030	*See* IS-M-276
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3	5:28234	*See* BNL-27878
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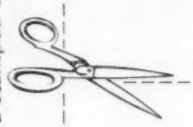

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